COPY NO. ____

MARJORIE STREET PUMP STATION

CITY OF PORTSMOUTH

PORTSMOUTH, NEW HAMPSHIRE

BID # 55-23

BIDDING AND CONTRACT REQUIREMENTS AND SPECIFICATIONS

MAY 2023

20374A

WRIGHT-PIERCE
Engineering a Better Environment

CITY OF PORTSMOUTH

PORTSMOUTH, NEW HAMPSHIRE

BIDDING AND CONTRACT REQUIREMENTS AND SPECIFICATIONS

FOR

MARJORIE STREET PUMP STATION

BID #55-23

MAY 2023

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2023

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Rev 2/2022

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Advertisement for Bids

Owner Name: City of Portsmouth		Project Number: 20374		
Project Address:	Marjorie Street	Portsmouth	NH	03801
	Street # and name	City/Town	State	ZIP

Separate sealed BIDS for the construction of: #55-23 Marjorie Street pump station including installation of a 4-inch HDPE force main will be received by City of Portsmouth at the office of the Finance Department, 1 Junkins Avenue, Portsmouth, NH 03801 until 2:00 PM Local Time on July 20, 2023 and then at said office publicly opened and read aloud.

1. Completion time for the project will be calculated as calendar days from the date specified in the "Notice to Proceed" as follows:
   300 calendar days for substantial completion.
   330 calendar days for final completion
   Liquidated damages will be in the amount of $1,000, for each calendar day of delay from the date established for substantial completion, and $1,000 for each calendar day of delay from the date established for final completion.
2. Each General Bid shall be accompanied by a Bid Security in the amount of 5% of the Total Bid Price.
3. The successful Bidder must furnish 100% Performance and Payment Bonds and will be required to execute the Contract Agreement within 10 days following notification of the acceptance of their Bid.
4. Any contract or contracts awarded under this Advertisement for Bids are expected to be funded in whole or in part by: **(Select all appropriate.)**
   - ☐ A loan from the NH Clean Water State Revolving Fund.
   - ☐ A loan from the NH Drinking Water State Revolving Fund.
   - ☐ A loan from the NH Drinking Water and Groundwater Trust Fund.
   - ☐ A grant from the NH Drinking Water and Groundwater Trust Fund.
   - ☒ A State Aid Grant from the NH Department of Environmental Services (SAG).
   - ☐ A grant from the American Rescue Plan Act from the NH Department of Environmental Services (ARPA).
   - ☐ A loan or grant from USDA Rural Development.
   - ☐ A Community Development Block Grant (CDBG) from the NH Community Development Finance Authority.
5. No Bidder may withdraw a Bid within 60 days after the actual date of opening thereof.
6. There will be a MANDATORY pre-bid meeting on June 28th @ 10:00AM held at the Department of Public Works 680 Peverly Hill Rd. Portsmouth, NH 03801.

The Contract Documents may be examined at the following locations:

Electronic copies may be viewed at the Wright-Pierce website: www.wright-pierce.com

Or at: www.cityofportsmouth.com/finance/purchasing-bids-and-proposals.com

Questions shall be directed to purchasing@cityofportsmouth.com no later than July 10, 2023 @ 4:30 p.m. Addenda to this proposal document, if any, including written answers to questions, will be posted on the City of Portsmouth website. Addenda and updates will NOT be sent directly to vendors.

The City of Portsmouth reserves the right to reject any or all proposals, to waive technical or legal deficiencies, and to accept and negotiate the terms of any proposal that it may deem to be in the best interest of the City.

Information for Bidders

All Contracts

Bids will be received by: City of Portsmouth herein called the "OWNER" at:
Address: 1 Junkins Avenue Portsmouth NH 03801
Each BID must be submitted in a sealed envelope, addressed to:

Finance/Purchasing Department at 1 Junkins Avenue, Portsmouth, NH 03801.

Each sealed envelope containing a BID must be plainly marked on the outside as BID for #55-23 Marjorie Street Pump Station and the envelope should bear on the outside the BIDDER's name, address and license number if applicable and the name of the project for which the BID is submitted. If forwarded by mail, the sealed envelope containing the BID must be enclosed in another envelope addressed to the OWNER at 1 Junkins Avenue, Portsmouth, NH 03801.

All BIDS must be made on the required BID form. All blank spaces for BID prices must be filled in, in ink or typewritten, and the BID form must be fully completed and executed when submitted. Only one copy of the BID form is required.

The OWNER may waive any informalities or minor defects or reject any and all BIDS. Any BID may be withdrawn prior to the above scheduled time for the opening of BIDS or authorized postponement thereof. Any BID received after the time and date specified shall not be considered. No BIDDER may withdraw a BID within 60 days after the actual date of the opening thereof. Should there be reasons why the contract cannot be awarded within the specified period, the time may be extended by mutual agreement between the OWNER and the BIDDER.

BIDDERS must satisfy themselves of the accuracy of the estimated quantities in the BID SCHEDULE by examination of the site and a review of the drawings and specifications including ADDENDA. After BIDS have been submitted, the BIDDER shall not assert that there was a misunderstanding concerning the quantities of WORK or of the nature of the WORK to be done.

The OWNER shall provide to BIDDERS prior to BIDDING, all information which is pertinent to, and delineates and describes, the land owned and rights-of-way acquired or to be acquired.

The CONTRACT DOCUMENTS contain the provisions required for the construction of the PROJECT. Information obtained from an officer, agent, or employee of the OWNER or any other person shall not affect the risks or obligations assumed by the CONTRACTOR or relieve them from fulfilling any of the conditions of the contract.

Each BID must be accompanied by a BID BOND payable to the OWNER in the amount of five percent (5%) of the total amount of the BID. As soon as the BID prices have been compared, the OWNER will return the BONDS of all except the three lowest responsive BIDDERS. When the AGREEMENT is executed, the bonds of the two remaining unsuccessful BIDDERS will be returned. The BID BOND of the successful BIDDER will be retained until the PAYMENT BOND and PERFORMANCE BOND have been executed and approved, after which it will be returned. A certified check may be used in lieu of a BID BOND.

A PERFORMANCE BOND and a PAYMENT BOND, each in the amount of 100 percent of the CONTRACT PRICE, with a corporate surety approved by the OWNER, will be required for the faithful performance of the contract.

Attorneys-in-fact who sign BID BONDS or PAYMENT BONDS and PERFORMANCE BONDS must file with each BOND a certified and effective dated copy of their power of attorney.

The party to whom the contract is awarded will be required to execute the AGREEMENT and obtain the PAYMENT BOND and PERFORMANCE BOND within ten (10) calendar days from the date when NOTICE OF AWARD is delivered to the

BIDDER. The NOTICE OF AWARD shall be accompanied by the necessary AGREEMENT and BOND forms. In case of failure of the BIDDER to execute the AGREEMENT, the OWNER may at their option consider the BIDDER in default, in which case the BID BOND accompanying the proposal shall become the property of the OWNER.

The OWNER within ten (10) days of receipt of acceptable PAYMENT BOND, PERFORMANCE BOND and AGREEMENT signed by the party to whom the AGREEMENT was awarded shall sign the AGREEMENT and return to such party an executed duplicate of the AGREEMENT. Should the OWNER not execute the AGREEMENT within such period, the BIDDER may by WRITTEN NOTICE withdraw their signed AGREEMENT. Such notice of withdrawal shall be effective upon receipt of the notice by the OWNER.

The NOTICE TO PROCEED shall be issued within ten (10) days of the execution of the Agreement by the OWNER. Should there be reasons why the NOTICE TO PROCEED cannot be issued within such period, the time may be extended by mutual agreement between the OWNER and CONTRACTOR. If the NOTICE TO PROCEED has not been issued within the ten (10) day period or within the period mutually agreed upon, the CONTRACTOR may terminate the AGREEMENT without further liability on the part of either party.

The OWNER may make such investigations as Owner deems necessary to determine the ability of the BIDDER to perform the WORK, and the BIDDER shall furnish to the OWNER all such information and data for this purpose as the OWNER may request. The OWNER reserves the right to reject any BID if the evidence submitted by, or investigation of, such BIDDER fails to satisfy the OWNER that such BIDDER is properly qualified to carry out the obligations of the AGREEMENT and to complete the WORK contemplated therein.

A conditional or qualified BID will not be accepted.

Award will be made to the lowest responsive and responsible BIDDER.

All applicable laws, ordinances, and the rules and regulations of all authorities having jurisdiction over construction of the PROJECT shall apply to the contract throughout.

Each BIDDER is responsible for inspecting the site and for reading and being thoroughly familiar with the CONTRACT DOCUMENTS. The failure or omission of any BIDDER to complete any of the foregoing shall in no way relieve any BIDDER from any obligation in respect to their BID.

The low BIDDER shall supply the names and addresses of major material SUPPLIERS and SUBCONTRACTORS when requested to do so by the OWNER.

MANUFACTURER'S EXPERIENCE

Wherever it may be written that an equipment manufacturer must have a specified period of experience with their product, equipment which does not meet the specified experience period can be considered if the equipment supplier or manufacturer is willing to provide a bond or cash deposit for the duration of the specified time period which will guarantee replacement of that equipment in the event of failure.

PROJECT SIGN

The Contractor shall construct a sign in accordance with the Standard Detail included in these specifications. The sign shall be erected in a location selected by the Engineer or Owner in coordination with NHDES. The Contractor shall maintain the sign throughout the duration of the contract.

SAFETY AND HEALTH REGULATIONS

This project is subject to all the Safety and Health Regulations (CFR 29 Part 1926 and all subsequent amendments) as promulgated by the U.S. Department of Labor on June 24, 1974. Contractors shall comply with the requirements of these regulations.

NONDISCRIMINATION IN EMPLOYMENT

Contracts for work under this proposal will obligate the contractors and sub-contractors not to discriminate in employment practices.

STATE INSPECTION

Work performed on this project shall be subject to inspection by representatives of the New Hampshire Department of Environmental Services (NHDES). Such inspection shall in no sense make the State Government a party to this contract, unless said Government is also the Owner, and will in no way interfere with the rights of either party hereunder.

Representatives of NHDES shall be given Right of Access to all portions of the proposed work, including but not limited to actual work site, storage yards, offsite manufacturing and fabricating location and job records.

COPIES OF THE CONTRACT

There shall be at least five (5) executed copies of the Contract to be distributed as follows:

a) One (1) copy each to the Owner, Engineer and Contractor.
b) One electronic copy in PDF format to NHDES.
c) Additional copies as required for other federal or state agencies contributing to or participating in project costs.

NON-RESIDENT CONTRACTORS

The successful bidder, if a corporation established under laws other than the State of New Hampshire, shall file, at the time of the execution of the contract, with the Owner, notice of the name of its resident attorney, appointed as required by the laws of the State of New Hampshire.

The successful bidder, if not a resident of New Hampshire, and not a corporation, shall file, at the time of execution of the contract, with the Owner a written appointment of a resident of the state of New Hampshire, having an office or place of business therein, to be their true and lawful attorney upon whom all lawful processes in any actions or proceedings against them may be served; and in such writing, which shall set forth said attorney's place of residence, shall agree that any lawful process against them which is served on said attorney shall be of the same legal force and validity as if served on them and that the authority shall continue in force so long as any liability remains outstanding against them in New Hampshire.

The power of attorney shall be filed in the office of the Secretary of State if required, and copies certified by the Secretary shall be sufficient evidence thereof. Such appointment shall continue in force until revoked by an instrument in writing, designating in a like manner some other person upon whom such processes may be served, which instrument shall be filed in the manner provided herein for the original appointment.

A Non-resident Contractor shall be deemed to be:

a) A person who is not a resident of the State of New Hampshire.
b) Any partnership that has no member thereof resident of the State of New Hampshire.
c) Any corporation established under laws other than those of the State of New Hampshire.

BIDDERS QUALIFICATIONS

No award will be made to any Bidder who cannot meet all of the following requirements:

A. He shall not have defaulted nor turned the work over to the bonding company on any contract within three years prior to the bid date.
B. He shall maintain a permanent place of business.
C. He shall have adequate personnel and equipment to perform the work expeditiously.
D. He shall have suitable financial status to meet obligations incidental to the work.
E. He shall have appropriate technical experience satisfactory to the Engineer and the Division in the class of work involved.
F. He shall be registered with the Secretary of State to do business in New Hampshire.
G. He shall have performed to the satisfaction of the Engineer and the Division on previous contracts of a similar nature.
H. He shall not have failed to complete previous contracts on time, including approved time extensions.

WITHDRAWAL OF BIDS

Prior to Bid Opening, bids may be withdrawn upon written or telegraphic request of the Bidder provided confirmation of any telegraphic withdrawal over the signature of the Bidder is placed in the mail and postmarked prior to the time set for Bid Opening. Bid documents and security of any Bidder withdrawing their bid in accordance with the foregoing conditions will be returned

INTERPRETATIONS AND ADDENDA

All questions about the meaning or intent of the Bidding Documents shall be addressed to the Procurement Coordinator at purchasing@cityofportsmoth.com

Interpretations or clarifications considered necessary by Owner in response to such questions will be issued by Addenda which will be posted to the City's website at https://www.cityofportsmouth.com/finance/purchasing-bids-and-proposals.

Questions received less than seven days prior to the date for opening of Bids may not be answered. Only questions answered by Addenda will be binding. Oral and other interpretations or clarifications will be without legal effect.

Addenda may be issued to clarify, correct, supplement, or change the Bidding Documents. Addenda will be issued not later than five working days before the bid opening. Bidders are responsible for determining that they have received all Addenda issued.

RESERVATION OF RIGHTS

The City of Portsmouth reserves the right to reject any or all proposals, to waive technical or legal deficiencies, and to accept and negotiate the terms of any proposal that it may deem to be in the best interest of the City.

Bid

Proposal of _____ [company](hereinafter called the "BIDDER", organized and existing under the laws of the State of __ doing business as Corporation, Partnership, Individual to the City of Portsmouth (herein after called "OWNER").

In compliance with your Advertisement for Bids, BIDDER hereby proposes to perform all WORK For the construction of Marjorie Street Pump Station in strict accordance with the CONTRACT DOCUMENTS, within the time set forth therein, and at the prices stated below.

By submission of this BID, each BIDDER certifies, and in the case of a joint BID each party thereto certifies as to their own organization, that this BID has been arrived at independently, without consultation, communication, or agreement as to any matter relating to the BID with any other BIDDER or with any competitor.

BIDDER hereby agrees to commence WORK under this contract on or before a date to be specified in the NOTICE TO PROCEED and to complete the PROJECT within:

300 calendar days for substantial completion.
330 calendar days for final completion

Liquidated damages will be in the amount of $1,000 for each calendar day of delay from the date established for substantial completion and $1,000 for each calendar day of delay from the date established for final completion, as provided in Section 18 of the General Conditions.

BIDDER acknowledges receipt of the following ADDENDUM:

1 _____
2 _____
3 _____
4 _____
5 _____

The Bidder shall state below what works of a similar character to that of the proposed contract they have performed, and provide such references as will enable the Owner to judge their experience, skill, and business standing.

All questions must be answered and the data given must be clear and comprehensive. This statement must be notarized. If necessary, add separate sheets.

Bidder Name:				
Permanent Main Office Address:	Street # and name		City/Town	State ZIP
When was it organized:			Where incorporated?	
☐ Yes	☐ No	Is the bidder registered with the Secretary of State to do business in NH?		
For how many years has your firm engaged in the contracting business under its present name? Please list previous firm names and dates if applicable.				
Years		Previous Name		
Contracts on hand, attach a schedule or list showing gross amount of each contract and the approximate anticipated dates of completion.				
Describe the general character of work performed by your company.				
☐ Yes	☐ No	Have you ever failed to complete any work awarded you in the scheduled contract time, including approved time extensions? If so where and why?		
☐ Yes	☐ No	Have you ever defaulted on a contract? If so where and why?		
☐ Yes	☐ No	Have you ever had liquidated damages assessed on a contract? If so where and why?		
List the more important contracts recently executed by your company:				
Recent Contract Name			Approximate Cost	Month/Year Completed
List your major equipment **available for this contract**: (Attach additional sheets as necessary.)				
List your key personnel **available for this contract**: (Attach additional sheets as necessary.)				
Staff Name			Role (i.e. Project Superintendent, Foreman)	

List any subcontractors whom you would expect to use for the following (unless this work is to be done by your own organization)		
Civil Engineering Utility Installation Other please describe:		
Please list banks with whom you conduct business.		
☐ Yes	☐ No	Do you grant the Engineer permission to contact this (these) institutions?
NOTE: Bidders may be required to furnish their latest financial statement as part of the award process.		

Respectfully Submitted:

Signature: _____ Date:

Printed Name: Title:

Street # and name City/Town State ZIP

[Signed Name] Being duly sworn, deposes and says that they are [Position Title] of [Organization] and all the answers to the foregoing questions and all statement contained therein are true and correct.

Sworn to before me this day of , 20

, Notary Public

My Commission Expires

Seal

Attest:

BIDDER agrees to perform all the work described in the CONTRACT DOCUMENTS for the following unit prices or lump sum:

NOTE: BIDS shall include sales tax and all other applicable taxes and fees.

BID SCHEDULE

BASE BID

Item No.	Qty	Unit	Brief Description of Item with Unit Bid Price in Words	Unit Bid In Figures	Amount In Figures
1	1	LS	Mobilization The sum of $_____ Per Lump Sum	$_____	$_____
2	1	LS	Marjorie Street Pump Station Upgrade – Complete except as noted below. The sum of $_____ Per Lump Sum	$_____	$_____
3	900	LF	4-inch HDPE Force Main, All Depths The sum of $_____ Per Linear Foot	$_____	$_____
4	130	LF	8-inch Diameter PVC Gravity Sewer, All Depths The sum of $_____ Per Linear Foot	$_____	$_____
5	20	VF	4-foot Diameter Sewer Manhole, All depths The sum of $_____ Per Vertical Foot	$_____	$_____
6	10*	CY	Ledge Excavation and Disposal The sum of $_____ Per Cubic Yard	$_____	$_____
7	60	TN	Initial Trench Paving (Binder Course) The sum of $_____ Per Ton	$_____	$_____
8	100	TN	Final Trench Paving (Surface Course) The sum of $_____ Per Ton	$_____	$_____
9	10*	TN	Bituminous Concrete Driveways The sum of $_____ Per Ton	$_____	$_____
10	1	AL	Traffic Control Allowance The sum of $Ten Thousand. Per Allowance	$10,000	$10,000

Item No.	Qty	Unit	Brief Description of Item with Unit Bid Price in Words	Unit Bid In Figures	Amount In Figures
11	1	AL	Uniformed Police Officer Allowance The sum of $Ten Thousand Per Allowance	$10,000	$10,000
12	1	AL	Utility Service Allowance The sum of $Forty Thousand Per Allowance	$40,000	$40,000
13	1	AL	Programming Integration Services Allowance The sum of $_____ Per Allowance	$13,635	$13,635
14	950	LF	Removal and Disposal of Asbestos Cement Pipe The sum of $_____ Per Linear Foot	$_____	$_____
15	15	CY	Unsuitable Earth Excavation Below Grade and Replacement Backfill The sum of $_____ Per Cubic Yards	$_____	$_____

Total Base Bid (Sum of Items 1 through 15) $_____

Sum of_____

Total Base Bid (Sum of Items 1 through 15) in Words Above

Determination of the low Bidder shall be based on the lowest Total Base Bid cost. See Specification Sections 01150 Measurement and Payment for a complete description of the Bid Items 1 through 15.

Bid Bond

KNOW ALL MEN BY THESE PRESENTS, that we, the undersigned as _____ Principal, and as _____ Surety, are hereby held and firmly bound unto _____ as OWNER in the penal sum of _____ for the payment of which, well and truly to be made, we hereby jointly and severally bind ourselves, successors and assigns.

Signed, this _____ day of _____ in the year ____.

The condition of the above obligation is such that whereas the Principal has submitted to _____ a certain BID, attached hereto and herby made a part hereof to enter into a contract in writing, for the _____

NOW, THEREFORE,

(a) If said BID shall be rejected, or

(b) If said BID shall be accepted and the Principal shall execute and deliver a contract in the Form of Contract attached hereto (Properly completed in accordance with said BID) and shall furnish a BOND for faithful performance of said contract, and for the payment of all persons performing labor or furnishing materials in connection therewith, and shall in all other respects perform the agreement created by the acceptance of said BID, then this obligation shall be void, otherwise, the same shall remain in force and effect; it being expressly understood and agreed that the liability of the Surety for any and all claims hereunder shall, in no event, exceed the penal amount of this obligation as herein stated.

The Surety, for value received, hereby stipulates and agrees that the obligations of said Surety and its BOND shall be in no way impaired or affected by any extension of the time within which the OWNER may accept such BID; and said Surety does hereby waive notice of any such extension.

IN WITNESS WHEREOF, the Principal and the Surety have hereunto set their hands and seals, and such of them as are corporations have caused their corporate seals to be hereto affixed and these presents to be signed by their proper officers, the day and year first set forth above.

Principal Signature	Witnessed By:
Surety Signature	Witnessed By:

IMPORTANT-Surety companies executing BONDS must appear on the Treasury Department's most current list (Circular 570 as amended) and be authorized to transact business in the state of New Hampshire.

2023

NHDES Front End Documents
Section B: Contract

Section B: Contract

NOTICE OF AWARD 1

ACKNOWLEDGEMENT OF NOTICE 2

AGREEMENT 3

PAYMENT BOND 5

PERFORMANCE BOND 7

NOTICE TO PROCEED 9

ACKNOWLEDGEMENT OF NOTICE 9

CHANGE ORDER 10

CERTIFICATE OF SUBSTANTIAL COMPLETION 11

CERTIFICATE OF FINAL COMPLETION 13

CONTRACTORS AFFIDAVIT 14

CONTRACTOR'S FINAL RELEASE AND WAIVER OF LIEN 15

NOTICE OF AWARD

Dated _____

TO:

ADDRESS:

Street Address | City/Town | State | ZIP

Project Number 20374A	Owner Contract Number
Project : #55-23 Marjorie Street Pump Station	Contract For: City of Portsmouth

Insert the name of the contract as it appears on the bid documents

You are notified that your bid dated _____ for the above contract has been considered. You are the apparent successful bidder and have been awarded a contract for:

_____

_____

_____

(Indicate total Work, alternates or sections of Work awarded)

The Contract Price of your contract is _____ dollars ($_____).

_____ copies of each of the proposed Contract Documents (except Drawings) accompany this Notice of Award. The same number of sets of the drawings will be delivered separately or otherwise made available to you immediately.

You must comply with the following conditions precedent within 10 days of receiving this Notice of Award.

1. You must deliver to the OWNER all of the fully executed counterparts of the Agreement including all the Contract Documents. This includes the sets of drawings. Each of the Contract Documents must bear your signature on (the cover) (every) page.
2. You must deliver with the executed Agreement the Contract Security (Bonds) as specified in the Information for Bidders and General Conditions.
3. (List all other conditions of precedent.)
   Proof of Insurance Coverage

   _____

   _____

   _____

Failure to comply with these conditions within the time specified will entitle **OWNER** to consider your bid abandoned, to annul this Notice of Award and to declare your Bid Security forfeited.

Within 10 days after receipt of acceptable performance **BOND**, payment **BOND** and agreement signed by the party to whom the Agreement was awarded, the **OWNER** will return to you, if requested, one fully signed counterpart of the Agreement with the Contract Documents attached.

_____
(OWNER)

_____
(Authorized Signature)

_____
(Title)

ACKNOWLEDGEMENT OF NOTICE

Receipt of the above NOTICE OF AWARD is hereby acknowledged:

By: _____, The _____ day of _____, 20___ by _____ title _____.

Copy to ENGINEER (Use Certified Mail, Return Receipt Requested)

AGREEMENT

THIS AGREEMENT, made this _____ day of _____, 20___ by and between _____, hereinafter called "**OWNER**" and _____ doing business as _____ (an individual, a partnership or a corporation) hereinafter called "**CONTRACTOR**".

WITNESSETH: That for and in consideration of the payments and agreements hereinafter mentioned:

1. The **CONTRACTOR** will commence and complete the construction of Marjorie Street Pump Station.
2. The **CONTRACTOR** will furnish all of the material, supplies, tools, equipment, labor and other services necessary for the construction and completion of the **PROJECT** described herein.
3. The **CONTRACTOR** will commence the work required by the **CONTRACT DOCUMENTS** within 30 calendar days after the date of the **NOTICE TO PROCEED** unless the period for completion is extended otherwise by the **CONTRACT DOCUMENTS**. Completion time for the project will be calculated as calendar days from the date specified in the **NOTICE TO PROCEED** as follows:
   300 calendar days for substantial completion.
   330 calendar days for final completion.
   Liquidated damages will be in the amount of $1,000 for each calendar day of delay from the date established for the substantial completion and $1,000 for each calendar day of delay from the date established for final completion.
4. The **CONTRACTOR** agrees to perform all of the **WORK** described in the **CONTRACT DOCUMENTS** and comply with the terms therein for the sum of $_____ or as shown in the **BID** schedule.
5. The term "**CONTRACT DOCUMENTS**" means and includes the following:
   a. ADVERTISEMENT FOR BIDS
   b. INFORMATION FOR BIDDERS
   c. BID
   d. BID BOND
   e. NOTICE OF AWARD
   f. AGREEMENT
   g. PAYMENT BOND
   h. PERFORMANCE BOND
   i. CERTIFICATE OF INSURANCE
   j. NOTICE TO PROCEED
   k. CHANGE ORDER(S)
   l. CERTIFICATON OF SUBSTANTIAL COMPLETION
   m. CERTIFICATION OF FINAL COMPLETION
   n. CONTRACTOR'S AFFIDAVIT
   o. CONTRACTOR'S RELEASE
   p. GENERAL CONDITIONS
   q. SUPPLEMENTAL GENERAL CONDITIONS
   r. SPECIAL CONDITIONS
   s. FEDERAL PROVISIONS, RULES, REGULATIONS AND FORMS
   t. DRAWINGS prepared by: Wright-Pierce numbered _____ through _____ and dated _____, 20___
   u. SPECIFICATIONS prepared or issued by: Wright-Pierce and dated _____, 20___
   v. ADDENDA

No. _____ dated _____, 20___

No. _____ dated _____, 20___

No. _____ dated _____, 20___

No. _____ dated _____, 20___

6. The **OWNER** will pay to the **CONTRACTOR** in the manner and at such times as set forth in the General Conditions such amounts as required by the **CONTRACT DOCUMENTS.**
7. This agreement shall be binding upon all parties hereto and their respective heirs, executors, administrators, successors and assigns.

IN WITNESS WHEREOF, the parties hereto have executed, or caused to be executed by their duly authorized officials this Agreement in ___ copies, each of which shall be deemed an original on the date first above written.

OWNER: _____

By: _____

NAME: _____

(SEAL)
ATTEST: _____

NAME: _____

TITLE: _____

CONTRACTOR: _____

BY: _____

NAME: _____

ADDRESS: _____

(SEAL)
ATTEST: _____

NAME: _____

TITLE: _____

PAYMENT BOND

KNOW ALL MEN BY THESE PRESENTS: that

_____, (contractor name),
_____, (contractor address), a
_____(corporation partnership, individual), hereinafter called Principal, and _____, (surety name),
_____, (surety address) herein after called surety, are held and firmly bound unto _____, (owner name), _____, (owner address) hereinafter called OWNER and unto all persons, firms, and corporations who or which may furnish labor, or who furnish materials to perform as described under the contract and to their successors and assigns, in the total aggregate penal sum of _____dollars, ($_____) in lawful money of the United States, for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION is such that whereas, the Principal entered into a certain contract with the **OWNER**, dated the _____ day of _____, 20___, a copy of which is hereto attached and made a part hereof for the construction of _____.

NOW, THEREFORE, if the Principal shall promptly make payment to all persons, firms, and corporations furnishing materials for or performing labor in the prosecution of the **WORK** provided for in such contract, and any authorized extension or modification thereof, including all amounts due for materials, lubricants, oil, gasoline, coal and coke, repairs on machinery, equipment and tools, consumed or used in connection with the construction of such **WORK**, and for all labor cost incurred in such WORK including that be a subcontractor, and to any mechanic or materialman lienholder whether it acquires its lien by operation of State or Federal Law; then this obligation shall be void; otherwise to remain in full force and effect.

PROVIDED, that beneficiaries or claimants hereunder shall be limited to the subcontractors, and persons, firms, and corporations having a direct contract with the PRINCIPAL or its SUBCONTRACTORS.

PROVIDED FURTHER, that the said Surety for value received hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the contract or to the **WORK** to be performed thereunder or the **SPECIFICATIONS** accompanying the same shall in any way affect its obligation on this **BOND**, and it does hereby waive notice of any such change, extension of time, alteration or addition to the terms of the contract or to the **WORK** or to the **SPECIFICATIONS**.

PROVIDED, FURTHER that no suit or action shall be commenced hereunder by any claimant: (a) Unless claimant, other than one having a direct contract with the PRINCIPAL shall have given written notice to any two of the following: The PRINCIPAL, the OWNER, or the SURETY above named within ninety (90) days after such claimant did or performed the last of the work or labor, or furnished the last of the materials for which said claim is made, stating with substantial accuracy the amount claimed and the name of the party to whom the materials were furnished, or for whom the work or labor was done or performed. Such notice shall be served by mailing the same by registered mail or certified mail, postage prepaid, in an envelope addressed to the PRINCIPAL, OWNER, or SURETY, at any place where an office is regularly maintained for the transaction business, or served in any manner in which legal process may be served in the state in which the aforesaid project is located, save that such service need not be made by a public officer; (b) After the expiration of one (1) year following the date on which PRINCIPAL ceased work on said CONTRACT, it being understood, however, that if any limitation embodied in the BOND is prohibited by any law controlling the construction hereof, such limitation shall be deemed to be amended so as to be equal to the minimum period of limitation permitted by such law.

PROVIDED, FURTHER, that it is expressly agreed that this BOND shall be deemed amended automatically and immediately, without formal and separate amendments hereto, upon amendment to the Contract not increasing the contract price more than 20 percent, so as to bind the PRINCIPAL and the SURETY to the full and faithful performance of the Contract as so amended. The term "Amendment", wherever used in this BOND and whether referring to this BOND, the contract or the loan Documents shall include any alteration, addition, extension or modification of any character whatsoever.

PROVIDED FURTHER, that no final settlement between the **OWNER** and the **CONTRACTOR** shall abridge the right of any beneficiary hereunder, whose claim may be unsatisfied.

IN WITNESS WHEREOF, this instrument is executed in _____ counterparts, each one of which shall be deemed an original this day of _____, 20___

ATTEST:

_____
(PRINCIPAL)

BY: _____
(Principal) Secretary

BY: _____

_____
(ADDRESS)

_____

BY: _____
Witness as to Principal

_____
(ADDRESS)

_____
(SURETY)

ATTEST:

BY: _____
(ATTORNEY in FACT)

BY: _____
Witness to Surety

_____
(ADDRESS)

_____

_____

_____

NOTE: Date of **BOND** must not be prior to date of Contract.
If **CONTRACTOR** is partnership, all partners should execute BOND.

IMPORTANT: Surety companies executing **BONDS** must appear on the Treasury Department's most current list (Circular 570 as amended) and be authorized to transact business in the State of New Hampshire.

PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS: that

_____, (contractor name),
_____, (contractor address), a
_____(corporation partnership, individual), hereinafter called
Principal, and _____, (surety name),
_____, (surety address) herein after called
surety, are held and firmly bound unto _____, (owner name),
_____, (owner address) hereinafter called
OWNER in the total aggregate penal sum of _____dollars, ($_____)in lawful money of the United States, for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION is such that whereas, the Principal entered into a certain contract with the **OWNER**, dated the _____ day of _____, 20___, a copy of which is hereto attached and made a part hereof for the construction of _____.

NOW, THEREFORE, if the Principal shall well, truly and faithfully perform its duties, all the undertakings, covenants, terms, conditions, and agreements of said contract during the original term thereof, and any extension thereof which may be granted by the **OWNER**, with or without notice to the Surety and during the one year guaranty period, and if the **PRINCIPAL** shall satisfy all claims and demands incurred under such contract, and shall fully indemnify and save harmless the **OWNER** from all costs and damages which it may suffer by reason of failure to do so, and shall reimburse and repay the **OWNER** all outlay and expense which the **OWNER** may incur in making good any default, then this obligation shall be void: otherwise to remain in full force and effect.

PROVIDED, FURTHER, that the said surety, for value received hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the contract or to **WORK** to be performed thereunder or the specifications accompanying same shall in any way affect its obligation on this **BOND**, and it does hereby waive notice of any such change, extension of time alteration or addition to the terms of the contract or to the **WORK** or to the specifications.

PROVIDED, FURTHER, that it is expressly agreed that this **BOND** shall be deemed amended automatically and immediately, without formal and separate amendments hereto, upon amendment to the Contract not increasing the contract price more than 20 percent, so as to bind the **PRINCIPAL** and the **SURETY** to the full and faithful performance of the Contract as so amended. The term "Amendment", wherever used in this **BOND** and whether referring to this **BOND**, the contract or the loan Documents shall include any alteration, addition, extension or modification of any character whatsoever.

PROVIDED, FURTHER, that no final settlement between the **OWNER** and the **CONTRACTOR** shall abridge the right of any beneficiary hereunder, whose claim may be unsatisfied.

IN WITNESS WHEREOF, this instrument is executed in _____ counterparts, each one of which shall be deemed an original this day of _____, 20___

ATTEST:

BY: _____
(Principal) Secretary

_____
(PRINCIPAL)

BY: _____

_____
(ADDRESS)

_____

BY: _____
Witness as to Principal

_____
(ADDRESS)

_____
(SURETY)

ATTEST:

BY: _____
(ATTORNEY in FACT)

BY: _____
Witness to Surety

_____
(ADDRESS)

_____

_____

_____

NOTE: Date of **BOND** must not be prior to date of Contract.
If **CONTRACTOR** is partnership, all partners should execute BOND.

IMPORTANT: Surety companies executing **BONDS** must appear on the Treasury Department's most current list (Circular 570 as amended) and be authorized to transact business in the State of New Hampshire.

NOTICE TO PROCEED

Dated _____ , 20 _____

TO: _____
(Insert Name of Contractor as it appears in the Bid Documents)

ADDRESS: _____

OWNER'S PROJECT NO. _____

PROJECT: Marjorie Street Pump Station

OWNER'S CONTRACT NO. _____

CONTRACT FOR: _____

You are notified that the Contract Time under the above contract will commence to run on _____, 20__. By that date, you are to start performing your obligations under the Contract Documents. In accordance with paragraph 3 of the Agreement, the dates of Substantial Completion and Final Completion are _____, 20__ and _____, 20__, respectively.

Before you may start any Work at the site, paragraph 27 of the General Conditions provides that you and Owner must each deliver to the other (with copies to ENGINEER) certificates of insurance which each is required to purchase and maintain in accordance with the Contract Documents. Also before you may start any Work at the site, you must:

_____

_____

Copy to ENGINEER
(Use Certified Mail, return receipt Requested)

OWNER: _____

BY: _____
(Authorized Representative)

NAME: _____
(Title)

ACKNOWLEDGEMENT OF NOTICE

Receipt of the above NOTICE TO PROCEED is hereby acknowledged by:

_____
(Contractor)

This the _____, day of 20__, by _____

Employee Identification Number: _____

CHANGE ORDER

No. _____

PROJECT NAME: _____ DATE OF ISSUANCE: _____

OWNER: _____ OWNER PROJECT NO. _____

OWNER ADDRESS: _____

Street Name City/Town State ZIP

CONTRACTOR: _____

CONTRACT FOR: _____

ENGINEER: _____ ENG. PROJECT NO.

ENGINEER ADDRESS: _____

Street Name City/Town State ZIP

You are directed to make the following changes in the Contract Documents.

Description: _____

Purpose of Change Order: _____

Justification: _____

Attachments: (List documents supporting change)

CHANGE IN CONTRACT PRICE	CHANGE IN CONTRACT TIME
Original Contract Price	Original Contract Time days date
Previous Change Orders	Net change from previous Change Orders days date
Contract Price prior to this Change Order	Contract Time prior to this Change Order days date
Net Increase (Decrease) of this Change Order	Net Increase (decrease) this Change Order days date
Contract Price with all approved Change Orders	Contract Time with all Change Orders days date

This document will become a supplement to the CONTRACT and all provisions will apply hereto. The attached Contractor's Revised Project Schedule reflects increases or decreases in Contract Time as authorized by this Change Order.

Stipulated price and time adjustment includes all costs and time associated with the above described change. Contractor waives all rights for additional time extension for said change. Contractor and Owner agree that the price(s) and time adjustment(s) stated above are equitable and acceptable to both parties.

RECOMMENDED BY:	APPROVED BY:	APPROVED BY:	APPROVED BY:
Engineer	Owner	Contractor	NHDES
Date	Date	Date	Date

CERTIFICATE OF SUBSTANTIAL COMPLETION

Owner Project No. _____ Engineer Project No. _____
Project: _____
Contractor: _____
Contract For: _____ Contract Date: _____

This Certificate of Substantial Completion applies to all work under the Contract Documents or to the following specified parts thereof:

_____
_____
_____

To _____
(Owner)

And to _____
(Contractor)

The Work to which this Certificate applies has been inspected by authorized representatives of OWNER, CONTRACTOR and ENGINEER, and that Work is hereby declared to be substantially complete in accordance with the Contract Documents on Documents on _____.
(Date of Substantial Completion)

A tentative list of items to be completed or corrected is attached hereto. This list may not be all-inclusive, and the failure to include an item in it does not alter the responsibility of CONTRACTOR to complete all the work in accordance with the Contract Documents. The items in the tentative list shall be completed or corrected by CONTRACTOR within _____ calendar days of the above Substantial Completion.

The responsibilities between OWNER and CONTRACTOR for security, operation, safety, maintenance, heat, utilities, insurance and warranties shall be as follows:

RESPONSIBILITIES:
OWNER: _____
_____
CONTRACTOR: _____
_____

The following documents are attached to and made a part of this Certificate:

_____
_____
_____
_____

This certificate does not constitute an acceptance of work not in accordance with the Contract Documents nor is it a release of CONTRACTOR's obligation to complete the work in accordance with the Contract Documents.

Executed by the Engineer on _____, 20__

_____
(Engineer)

By: _____

CONTRACTOR accepts this Certificate of Substantial Completion on _____, 20__

_____
(Contractor)

By: _____

OWNER accepts this Certificate of Substantial Completion on _____, 20__

_____
(Owner)

By: _____

CERTIFICATE OF FINAL COMPLETION

NHDES CLEAN WATER AND DRINKING WATER
STATE REVOLVING FUND

Owner Project No. _____ Engineer Project No. _____
Project: _____
Owner: _____
Contractor: _____
Engineer: _____
Agreement Date: _____
Notice to Proceed Date: _____
Contractual Substantial Completion date as modified by change orders: _____
Actual Substantial Completion date _____
Contractual final completion date as modified by Change Orders _____

The work to which this certificate applies has been inspected by authorized representatives of Owner, Contractor, Engineer and NHDES, the punch list has been completed and the work of the contract is hereby declared to be Finally Complete in accordance with the Contract Documents on _____.
(Date of Final Completion)

This certificate does not constitute an acceptance of any work not in accordance with the Contract Documents nor is it a release of contractor's obligation to complete the work in accordance with the Contract Documents. The warranty for all work completed subsequent to the date of Substantial Completion expires one year from the date of this Final Acceptance.

Executed by Engineer on _____, 20__

By: _____

Contractor Accepts this Certificate of Final Completion on _____, 20__

By: _____

Owner Accepts this Certificate of Final Completion on _____, 20__

By: _____

NHDES Accepts this Certificate of Final Completion on _____, 20__

By: _____

CONTRACTORS AFFIDAVIT

STATE OF: _____

COUNTY OF: _____

Before me the undersigned a _____ (Notary Public, Justice of the Peace, Alderman) in and for said County and State Personally appeared _____ (Individual, partner or duly) who being duly sworn according to law deposes and says that the cost of all the Work, and outstanding claims and indebtedness of whatever nature arising out of the performance of the contract between _____(Owner) and _____ (Contractor) of _____ (Contractor Address) dated _____ for the construction of the _____ (Project Name) and necessary appurtenant installations have been paid in full.

_____
(Individual, Partner, or duly authorized representative of corporate contractor)

_____
(Title)

Sworn to and subscribed before me
this _____ day of _____, 20__

_____
(Notary Public)

CONTRACTOR'S FINAL RELEASE AND WAIVER OF LIEN

Project Name: _____

Project Address: _____

Street Name City/Town State ZIP

Owner Name: _____

Contractor Name: _____

Contractor Address: _____

Street Name City/Town State ZIP

TO ALL WHOM IT MAY CONCERN:

For good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, the undersigned Contractor hereby waives, discharges, and releases any and all liens, claims, and rights to liens against the above-mentioned project, and any and all other property owned by or the title to which is in the name of the above-referenced Owner and against any and all funds of the Owner appropriated and available for the construction of said project, and any and all warrants drawn upon or issued against any such funds or monies, which the undersigned Contractor may have or may hereafter acquire or process as a result of the furnishing of labor, materials and/or equipment, and the performance of work by the Contractor on or in connection with said project, whether under and pursuant to the above-mentioned contract between the Contractor and the Owner pertaining to said project or otherwise, and which said liens, claims or rights of lien may arise and exist.

The undersigned further hereby acknowledges that the sum of:

_____ Dollars ($ _____) constitutes the entire ***unpaid*** balance due the undersigned in connection with said project whether under said contract or otherwise and that the payment of said sum to the contractor will constitute payment in full and will fully satisfy any and all liens, claims, and demands which the contractor may have or assert against the owner in connection with said contract or project.

Dated this _____ day of _____ 20__

_____

(Contractor)

Witness to Signature

BY: BY:

_____ _____

Title Title

2023

NHDES Front End Documents
Section C: General Conditions

General Conditions

Section C: General Conditions

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General Conditions

1. Contract and Contract Documents.

The plans, information for bidders, bids, advertisement for bids, bid payment and performance bonds, agreements, change orders, notice to proceed, specifications and addenda, hereinafter enumerated in the agreement, shall form part of this Contract and the provisions thereof shall be as binding upon the parties hereto as if they were herein fully set forth. The table of contents, titles, headings, running headlines and marginal notes contained herein and in said documents are solely to facilitate reference to various provisions of the Contract Documents and in no way affect, limit or cast light on the interpretation of the provisions to which they refer.

2. Definitions.

2.1 "Addenda" means written or graphic instruments issued prior to the execution of the agreement which modify or interpret the Contract Documents, drawings and specifications, by additions, deletions, clarifications or corrections. Such written or graphic instruments will be issued no less than five days before the bid opening.

2.2 "Bid" means the offer or proposal of the bidder submitted on the prescribed form setting forth the prices for the work to be performed.

2.3 "Bidder" means any person, firm or corporation submitting a bid for the work.

2.4 "Bonds" means bid, performance, and payment bonds and other instruments of security, furnished by the Contractor and his surety in accordance with the Contract Documents.

2.5 "Change Order" means a written order to the Contractor authorizing an addition, deletion or revision in the work within the general scope of the Contract Documents, or authorizing an adjustment in the Contract Price or Contract Time.

2.6 "Contract Documents" means the Contract, including any advertisement for bids, information for bidders, bid, bid bond, agreement, payment bond, performance bond, notice of award, notice to proceed, change orders, drawings, specifications and addenda.

2.7 "Contract Price" means the total monies payable to the Contractor under the terms and conditions of the Contract Documents.

2.8 "Contract Time" means the number of calendar days stated in the Contract Documents for the completion of the work.

2.9 "Contractor" means the person, firm or corporation with whom the owner has executed the agreement.

2.10 "Division" means the state of New Hampshire Department of Environmental Services, Water Division. "Drawings" mean the part of the Contract Documents which show the characteristics and scope of the work to be performed and which have been prepared or approved by the engineer.

2.11 "Engineer" means the person, firm or corporation named as such in the Contract Documents.

2.12 "Field order" means a written order effecting a change in the work not relating to an adjustment in the Contract price or an extension of the Contract time and issued by the engineer to the Contractor during construction.

2.13 "Notice of Award" means the written notice of the acceptance of the bid from the owner to the successful Bidder.

2.14 "Notice to Proceed" means the written communication issued by the owner to the Contractor authorizing him to proceed with the Work and establishing the date of commencement of the work.

2.15 "Owner" means a public or quasi-public body or authority, corporation, association, partnership, or individual for whom the work is to be performed.

2.16 "Plans" means the Contract drawings or exact reproductions thereof which show the scope, character, dimensions and details of the work and which have been prepared or approved by the engineer.

2.17 "Project" means the undertaking to be performed as provided in the Contract Documents.

2.18 "Resident Project Representative" means the authorized representative of the owner who is assigned to the project site or any part thereof.

2.19 "Shop Drawings" means all drawings, diagrams, illustrations, brochures, schedules and other data which are prepared by the Contractor, a subcontractor, manufacturer, supplier or distributor, which illustrates how specific portions of the work shall be fabricated or installed.

2.20 "Special conditions" means revisions or additions to these general conditions, supplemental general conditions or specifications applicable to an individual project.

2.21 "Specifications" means a part of the Contract Documents consisting of written descriptions of a technical nature of materials, equipment, construction systems, standards and workmanship.

2.22 "Subcontractor" means an individual, firm or corporation having a direct Contract with the Contractor or with any other Subcontractor for the performance of a part of the work at the site.

2.23 "Substantial Completion" means that date as certified by the engineer when the construction of the Project or a specified part thereof is sufficiently completed, in accordance with the Contract Documents, so that the project or specified part can be utilized for the purposes for which it is intended.

2.24 "Supplemental General Conditions" means modifications to these general conditions required by a federal agency for participation in the Project and approved by the agency in writing prior to inclusion in the Contract Documents, or such documents that may be imposed by applicable state laws.

2.25 "Supplier" means any person or organization who supplies materials or equipment for the work, including that fabricated to a special design, but who does not perform labor at the site.

2.26 "Work" means all labor necessary to produce the construction required by the Contract Documents, and all materials and equipment incorporated or to be incorporated in the project.

2.27 "Written Notice" means any notice to any party of the agreement relative to any part of this agreement in writing and considered delivered and the service thereof completed, when posted by certified or registered mail to the said party at his last given address, or delivered in person to said party or his authorized representative on the work.

3. Additional Instructions and Detail Drawings.

The Contractor may be furnished additional instructions and detail drawings as necessary to carry out the work included in the Contract. The additional drawings and instructions thus supplied to the Contractor will coordinate with the Contract Documents and will be so prepared that they can be reasonably interpreted as part thereof.

4. Shop or Setting Drawings. Shop or setting drawings shall be in accordance with the following:

4.1 The Contractor shall furnish 6 copies of the manufacturer's shop drawings, specific design data as required in the detailed specifications, and technical literature covering all equipment and fabricated materials which he proposes to furnish under this Contract in sufficient detail to indicate full compliance with the specifications. Shop drawings shall indicate the method of installing, the exact layout dimensions of the equipment or materials, including the location, size and details of valves, pipe connections, etc.

4.2 No equipment or materials shall be shipped until the manufacturer's shop drawings and specifications or other identifying data, assuring compliance with these specifications, are approved by the engineer.

4.3 The Contractor shall check and verify all field measurements and shall be responsible for the prompt submission of all shop and working drawings so that there shall be no delay in the work.

4.4 Regardless of corrections made in or approval given to such drawings by the engineer, the Contractor will nevertheless be responsible for the accuracy of such drawings and for their conformity to the plans and specifications. The Contractor shall notify the engineer in writing of any deviations at the time he furnishes such drawings. He shall remain responsible for the accuracy of the drawings showing the deviations but not for the acceptance of the deviations from the original design shown in the plans and specification. Approval by the engineer and the owner of any deviation in material, workmanship or equipment proposed subsequent to approval of the shop drawings or design data, shall be requested in writing by the Contractor.

4.5 When submitted for the engineer's review, shop drawings shall bear the Contractor's certification that he has reviewed, checked and approved the shop drawings and that they are in conformance with the requirements of the Contract Documents.

5. Materials, Services, Facilities and Workmanship shall be furnished as follows:

5.1 Except as otherwise specifically stated in the Contract Documents, the Contractor shall provide and pay for all materials, labor, tools, equipment, water, light, power, transportation, superintendence, temporary construction of every nature, and all other services and facilities of every nature whatsoever necessary to execute, complete, and deliver the work within the specified time.

5.2 Unless otherwise specifically provided for in the specifications, all workmanship, equipment, materials and articles incorporated in the work shall be new and the best grade of the respective kinds for the purpose.

5.3 The Contractor shall furnish to the engineer for approval the manufacturer's detailed specifications for all machinery, mechanical and other special equipment, which he contemplates installing together with full information as to type, performance characteristics, and all other pertinent information as required.

5.4 Materials which are specified by reference to the number or symbol of a specific standard, such as an ASTM standard, a federal specification or other similar standard, shall comply with requirements in the latest revision thereof and any amendment or supplement thereto in effect on the date of the advertisement for bids, except as limited to type, class or grade, or modified in such reference. The standards referred to shall have full force and effect as though printed therein.

5.5 For equipment or for materials, when requested by the engineer, the Contractor shall submit certificates of compliance from the manufacturer, certifying that the equipment or the materials comply with the requirements of the specifications or the standards.

5.6 Manufactured articles, materials, and equipment shall be applied, installed, connected, erected, used, cleaned and conditioned as directed by the manufacturer.

5.7 Materials, supplies, and equipment shall be in accordance with samples submitted by the Contractor and approved by the engineer.

6. Contractor's Title To Materials.

No material, supplies, or equipment to be installed or furnished under this Contract shall be purchased subject to any chattel mortgage or under a conditional sale, lease purchase or other agreement by which an interest therein or in any part thereof is retained by the seller or supplier. The Contractor shall warrant good title to all materials, supplies, and equipment installed or incorporated in the work and upon completion of all work, shall deliver the same together with all improvements and appurtenances constructed or placed thereon by him to the owner free from any claims, liens, or charges. Neither the Contractor nor any person, firm or corporation furnishing any material or labor for any work covered by this Contract shall have any right to a lien upon any improvement or appurtenance thereon. Nothing contained in this paragraph, however, shall defeat or impair the right of persons furnishing materials or labor to recover under any bond given by the Contractor for their protection or any rights under any law permitting such persons to look to funds due the Contractor in the hands of the owner. The provisions of this paragraph shall be inserted in all Subcontracts and material Contracts and notice of its provisions shall be given to all persons furnishing materials for the work when formal Contract is entered into for such materials.

7. Inspection and Testing of Materials shall be as follows:

7.1 All materials and equipment used in the construction of the project shall be subject to inspection and testing by the engineer in accordance with accepted standards at any and all times during manufacture or during the project construction and at any or all places where such manufacture is carried on.

7.2 The Contractor shall furnish promptly upon request by the engineer, all materials required to be tested. All tests made by the engineer shall be performed in such manner and ahead of scheduled installation, as not to delay the work of the Contractor. When required, testing of concrete, masonry, soils, pipe and pipe materials will be made in accordance with provisions in the specifications.

7.3 Material required to be tested which is delivered to the job site shall not be incorporated into the work until the tests have been completed and approval or acceptance given in writing by the engineer.

7.4 Each sample submitted by the Contractor for testing shall carry an identification label containing such information as is requested by the engineer. It shall also include a statement that the samples are representative of the remaining materials to be used on the project.

7.5 Approval of any materials shall be general only and shall not constitute a waiver of the owner's right to demand full compliance with the Contract requirements.

7.6 The engineer may, at his own discretion, undertake the inspection of materials at the source. In the event plant inspection is undertaken, the following conditions shall be met:

a. The engineer shall have the cooperation and assistance of the Contractor and the producer with whom he has Contracted for materials.

b. The engineer shall have full entry at all reasonable times to such areas as may concern the manufacture or production of the materials being furnished.

c. If required, the Contractor shall arrange for a building for the use of the inspector; such building to be located near the plant, independent of any building used by the material producer, in which to house and use the equipment necessary to carry on the required tests. Cost for such arrangement shall be paid by the owner as a stated allowance in the bid.

d. Adequate safety measures shall be provided and maintained at all times.

7.7 Except as otherwise specifically stated in the Contract, the costs of sampling and testing will be divided as follows:

a. The Contractor shall furnish the engineer, without extra cost, all samples required for testing purposes. All sampling and testing including the number and selection of samples shall be determined by the engineer for his own information and use.

b. When testing of materials is specified in the appropriate section of the specifications, the cost of the same shall be charged to the owner or Contractor, as detailed in the specifications. However, costs of equipment performance tests shall be borne by the Contractor, as detailed in the appropriate section of the specifications.

c. When the Contractor proposes a material, article or component as equal to the ones specified, reasonable tests may, or may not, be required by the engineer. If the engineer requires tests of a proposed equal item, the Contractor will be required to assume all costs of such testing.

d. Any material, article or component which fails to pass tests required by the Engineer or by the specifications, will be rejected and shall be removed from the project site. However, if, upon request of the Contractor, retesting or further tests are permitted by the Engineer, the Contractor shall assume all costs related to such retesting or further tests.

e. Neither the Owner nor the Engineer will in any way be charged for the manufacturer's costs in supplying certificates of compliance.

7.8 If the Contract Documents, laws, ordinances, rules, regulations or orders of any public authority having jurisdiction require any Work to specifically be inspected, tested or approved by someone other than the Contractor, the Contractor will give the Engineer timely notice of readiness. The Contractor will then furnish the Engineer with the required certificates of inspection, testing or approval.

7.9 Inspections, tests, or approvals by the engineer or others shall not relieve the Contractor from obligations to perform the Work in accordance with the requirements of the Contract Documents.

8. “Or Equal ” Clause, Substitutions and Contractor Options.

8.1 Whenever a material, article, or piece of equipment is identified on the plans or in the specifications by reference to manufacturer's or vendor's names, trade names, catalogue numbers, etc., it is intended merely to establish a standard of quality and performance. Any material, article, or equipment of other manufacturers and vendors, which will perform satisfactorily the duties imposed by the general design, shall be considered equally acceptable provided the material, article, or equipment so proposed is, in the opinion of the Engineer, of equal quality and function. The Engineer shall determine equality based on such information, tests, or other supporting data that may be required of the Contractor.

8.2 Upon acceptance and approval by the Engineer of an equal product, it shall remain the responsibility of the Contractor to coordinate installation of the item with all other items to be furnished to assure proper fitting together of all items. Similar responsibility applies to items which are left to the Contractor's option. Any

additional cost of equal items and any additional cost incidental to the coordination and/or fitting together of such items shall be borne by the Contractor at no extra cost to the Owner.

8.3 If a specified or equal item is not available to meet the construction schedule, the Contractor may propose a substitute item of less than equal performance and quality. If this substitute is acceptable to the Engineer, any difference in purchase cost or costs incidental to the installation of such item will be negotiated between the parties to the Contract.

8.4 Neither equal nor substitute items shall be installed without written approval of the Engineer.

8.5 The Contractor shall warrant that if substitutes are approved, no major changes in the function or general design of the Project will result.

9. Patents. Patent information is as follows:

9.1 The Contractor shall hold and save the owner and its officers, agents, servants, and employees harmless from liability of any nature or kind, including cost and expenses for, or on account of, any patented or unpatented invention, process, article, or appliance manufactured or used in the performance of the Contract, including its use by the owner, unless otherwise specifically stipulated in the Contract Documents.

9.2 License and/or royalty fees for the use of a process used in wastewater plant design which is authorized by the owner for the project, must be reasonable, and paid to the holder of the patent, or his authorized licensee.

9.3 If the Contractor uses any design, device or materials in the construction methods for the project covered by patents or copyrights, he shall provide for such use by suitable agreement with the owner of such patented or copyrighted design, device or material. It is mutually agreed and understood, that, without exception, the Contract prices shall include all royalties or costs arising from the use of such design, device or materials, in any way involved in the work. The Contractor and/or his sureties shall indemnify and save harmless the owner of the project from any and all claims for infringement by reason of the use of such patented or copyrighted design, device or materials or any trademark or copyright in connection with work agreed to be performed under this Contract, and shall indemnify the Owner for any cost, expense or damage which it may be obliged to pay by reason of such infringement at any time during the construction of the work or after completion of the work.

10. Surveys. Surveys of land, property and construction shall be as follows:

10.1 The owner will provide all land surveys and will establish and locate all property lines relating to the project.

10.2 For structures, the Engineer will establish and stake out one or more base lines as needed and will establish bench marks in and around the project site for the use of the Contractor and for the Engineer's own reference in checking the work in progress. For structures such as pipelines, the Engineer will establish the location of the pipe, manholes and other appurtenances, and will establish bench marks along the route of the pipeline at intervals for the using of the Contractor and for his own reference in checking the pipe and manhole inverts and other elevations throughout the project. The Contractor shall utilize the lines and bench marks established by the Engineer to set up whatever specific detail controls he may need for establishing location, elevation lines and grades of all structures. All this work is subject to checking, approval, and continuous surveillance by the Engineer to avoid error. The Contractor shall provide the Engineer with a qualified man or men to assist in this checking as needed and on request of the Engineer.

10.3 For construction other than pipelines and appurtenances in roadways and cross country, the Contractor shall be responsible for the location and setting lines and grades. The Contractor shall establish the location for pump

station and wastewater treatment facility structures, associated yard piping including electrical conduits, internal piping and all equipment. Base lines and benchmarks for setting of the lines and grades for the above shall be provided by the Engineer.

10.4 Protection of stakes. The Contractor shall protect and preserve all of the established baseline stakes, bench marks, or other controls placed by the Engineer. Any of these items destroyed or lost through fault of the Contractor will be replaced by the Engineer at the Contractor's expense.

11. Contractor's Obligations are as follows:

The Contractor shall and in good workmanlike manner, do and perform all work and furnish and pay for all supplies and materials, machinery, equipment, facilities and means, except as herein otherwise expressly specified, necessary or proper to perform and complete all the work required by this Contract, within the time stated in the proposal in accordance with the plans and drawings covered by this Contract, and any and all supplemental plans and drawings, in accordance with the directions of the Engineer as given from time to time during the progress of the work, whether or not he considers the direction in accordance with the terms of the Contract. He shall furnish, erect, maintain and remove such construction plant and such temporary works as may be required. The Contractor shall observe, comply with, and be subject to all terms, conditions, requirements, and limitations of the Contract Documents, and shall do, carry on and complete the entire work to the satisfaction of the Engineer and Owner.

Contractor shall carry on the work and adhere to the progress schedule during all disputes, disagreements or unresolved claims with the owner. No work shall be delayed or postponed pending the resolution of any disputes, disagreements, or claims except as the owner and Contractor may otherwise agree in writing.

12. Weather Conditions.

In the event of temporary suspension of work, or during inclement weather, or whenever the Engineer shall direct, the Contractor and his Subcontractors shall protect their work and materials against damage or injury from the weather. If, in the opinion of the Engineer, any work or material shall have been damaged or injured by reason of failure on the part of the Contractor or any of his Subcontractors to so protect his work, such materials shall be removed and replaced at the expense of the Contractor.

13. Protection of Work and Property shall be provided as follows:

13.1 The Contractor shall at all times safely guard the Owner's property from injury or loss in connection with this Contract. He shall at all times safely guard and protect his own work, and that of adjacent property, from damage. The Contractor shall replace or make good any such damage, loss or injury unless caused directly by errors contained in the Contract, or by the Owner, or his authorized representatives. The Contractor will notify owners of adjacent utilities when prosecution of the Work may affect them.

13.2 The Contractor shall take all necessary precautions for the safety of employees on the work site, and shall comply with all applicable provisions of federal, state and municipal safety laws and building codes to prevent accidents or injury to persons on, about or adjacent to the premises where the work is being performed. He shall erect and properly maintain at all times, as required by the conditions and progress of the work, all necessary safeguards for the protection of the workmen and the public and shall post danger signs warning against the hazards created by such features of construction as protruding nails, hoists, well holes, elevator hatchways, scaffolding, window openings, stairways, trenches and other excavations, and falling materials, and he shall designate a responsible member of his organization on the work, whose duty shall be the prevention of accidents. The name and position

of any person so designated shall be reported to the Engineer by the Contractor. The person so designated shall be available by phone during nonworking hours.

13.3 In case of emergency which threatens loss or injury of property, and/or safety of life, the Contractor is allowed to act, without previous instructions from the Engineer. He shall notify the Engineer immediately thereafter. Any claim for compensation by the Contractor due to such extra work shall be promptly submitted in writing to the Engineer for approval.

13.4 When the Contractor has not taken action but has notified the Engineer of an emergency threatening injury to persons or damage to the work or any adjoining property, he shall act as instructed or authorized by the Engineer.

13.5 The intention is not to relieve the Contractor from acting, but to provide for consultations between Engineer and Contractor in an emergency which permits time for such consultations.

13.6 The amount of reimbursement claimed by the Contractor on account of any emergency action shall be determined in the manner provided in Article 17 (extra work and change orders) of the general conditions.

14. Inspection of work for conformance with plans and specifications.

14.1 For purposes of inspection and for any other purpose, the Owner, the Engineer, and agents and employees of the Division or of any funding agency may enter upon the work and the premises used by the Contractor, and the Contractor shall provide safe and proper facilities therefore. The Engineer shall be furnished with every facility for ascertaining that the work is in accordance with the requirements and intention of this Contract, even to the extent of uncovering or taking down portions of finished work.

14.2 During construction and on its completion, all work shall conform to the location, lines, levels and grades indicated on the drawings or established on the site by the Engineer and shall be built in a workmanlike manner, in accordance with the drawings and specifications and the supplementary directions given from time to time by the Engineer. In no case shall any work which exceeds the requirements of the drawings and specifications be paid for as extra work unless ordered in writing by the Engineer.

14.3 Unauthorized work and work not conforming to plans and specifications shall be handled as follows:

a. Work considered by the Engineer to be outside of or different from the plans and specifications and done without instruction by the Engineer, or in wrong location, or done without proper lines or levels, may be ordered by the Engineer to be uncovered or dismantled.

b. Work done in the absence of the Engineer or his agent may be ordered by the Engineer to be uncovered or dismantled.

c. Should the work thus exposed or examined prove satisfactory, the uncovering or dismantling and the replacement of material and rebuilding of the work shall be considered as “Extra Work” to be processed in accordance with article 17.

d. Should the work thus exposed or examined prove to be unsatisfactory the uncovering or dismantling and the replacement of material and rebuilding of the work shall be at the expense of the Contractor.

15. Reports, Records and Data shall be furnished as follows: The Contractor shall submit to the owner such schedule of quantities and costs, progress schedules, payrolls, reports, estimates, records and other data as are required by the Contract Documents or as the owner, division or any funding agency may request concerning work performed or to be performed under this Contract.

16. **Superintendence by Contractor** shall be furnished as follows: At the site of the work, the Contractor shall employ a competent construction superintendent or foreman who shall have full authority to act for the Contractor. The superintendent or foreman shall have been designated in writing by the Contractor as the Contractor's representative at the site. It is understood that such representative shall be acceptable to the Engineer and shall be the one who can be continued in that capacity for the particular job involved unless he ceases to be on the Contractor's payroll. Such representative shall be present on the site at all times as required to perform adequate supervision and coordination of the Work.

17. **Extra Work and Change Orders** shall be processed as follows:

17.1 The Engineer may at any time by written order and without notice to the sureties require the performance of such extra work or changes in the work as may be found necessary. The amount of compensation to be paid to the Contractor for any extra work so ordered shall be made in accordance with one or more of the following methods in the order of precedence listed below:

a. A price based on unit prices previously approved; or

b. A lump sum price agreed upon between the parties and stipulated in the order for the extra work;

c. A price determined by adding 15 percent to the “reasonable cost” of the extra work performed, such “reasonable cost” to be determined by the Engineer in accordance with the following paragraph.

17.2 The Engineer shall include the reasonable cost to the Contractor of all materials used, of all labor, both common and skilled, of foreman, trucks, and the fair-market rental rate for all machinery and equipment for the period employed directly on the work. The reasonable cost for extra work shall include the cost to the Contractor of any additional insurance that may be required covering public liability for injury to persons and property, the cost of workmen's compensation insurance, federal social security, and any other costs based on payrolls, and required by law. The cost of extra work shall not include any cost or rental of small tools, buildings, or any portion of the time of the Contractor, his project supervisor or his superintendent, as assessed upon the amount of extra work, these items being considered covered by the 15 percent added to the reasonable cost. The reasonable cost for extra work shall also include the premium cost, if any, for additional bonds and insurance required because of the changes in the work.

17.3 In the case of extra work which is done by Subcontractors under the specific Contract, or otherwise if so approved by the Engineer, the 15 percent added to the reasonable cost of the work will be allowed only to the Subcontractor performing the work. On such work an additional 5 percent for reasonable cost will be paid to the Contractor for their work in directing the operations of the Subcontractor, for administrative supervision, and for any overhead costs. If two or more tiers of Subcontractors are involved in the extra work, a maximum of 27 percent of the cost incurred by the Subcontractor actually performing the work will be allowed to be added to the reasonable cost of the work. The 27 percent maximum represents 15 percent added to the reasonable cost of the work allowed by the Subcontractor performing the work, an additional 5 percent allowed to the next tier higher subcontractor and 5 percent allowed to the Contractor for their work in directing the operations of the Subcontractor, for administrative supervision, and for any overhead costs.

17.4 The Engineer may authorize minor changes or alterations in the work not involving extra cost and not inconsistent with the overall intent of the Contract Documents. These shall be accomplished by a written field order. However, if the Contractor believes that any minor change or alteration authorized by the Engineer entitles him to an increase in the Contract price, he may make a claim therefore as provided in article 21.

18. Time For Completion and Liquidated Damages. The following paragraphs address time for completion and liquidated damages:

18.1 It is hereby understood and mutually agreed, by and between the Contractor and the Owner, that the date of beginning and the time for completion as specified in the Contract of the work to be done hereunder are Essential Conditions of this Contract; and it is further mutually understood and agreed that the work embraced in this Contract shall be commenced on a date to be specified in the "Notice to Proceed."

18.2 The Contractor agrees that said work shall be pursued regularly, diligently and continuously at such rate of progress as will insure full completion thereof within the time specified. It is expressly understood and agreed, by and between the Contractor and the Owner, that the time for the completion of the work described herein is a reasonable time, taking into consideration the average climatic range and usual industrial conditions prevailing in this locality.

18.3 If the Contractor shall neglect, fail or refuse to complete the work within the time herein specified, or any proper extension thereof granted by the Owner, then the Contractor does hereby agree, as a part consideration for the awarding of this Contract, to pay to the Owner the amount specified in the Contract, not as a penalty but as liquidated damages for such breach of Contract as hereinafter set forth, for each and every calendar day that the Contractor shall be in default after the time stipulated in the Contract for completing the work.

18.4 The liquidated damages amount is fixed and agreed upon by and between the Contractor and the Owner because of the impracticability and extreme difficulty of fixing and ascertaining the actual damages the Owner would in such event sustain. Said amount is agreed to be the amount of damages which the Owner would sustain and said amount shall be deducted from time to time by the owner from current periodical payments.

18.5 It is further agreed that "time is of the essence" of each and every portion of this Contract and of the specifications wherein a definite and certain length of time is fixed for the performance of any act whatsoever; and where under the Contract an additional time is allowed for the completion of any work, the new time limit fixed by such extension shall "be of the essence." Provided, that the Contractor shall not be charged with liquidated damages or any excess cost when the Owner determines that the Contractor is without fault and the Contractor's reasons for the time extension are acceptable to the Owner; provided, further, that the Contractor shall not be charged with liquidated damages or any excess cost when the delay in the completion of the work is due to:

a. A preference, priority or allocation order duly issued by the government.

b. An unforeseeable cause beyond the control and without the fault or negligence of the Contractor, including, but not restricted to, acts of God, or of the public enemy, acts of the Owner, acts of another Contractor in the performance of a Contract with the Owner, fires, floods, epidemics, quarantine restrictions, strikes, freight embargoes and severe weather.

c. Any delays of Subcontractors or suppliers occasioned by any of the causes specified in subsections (a) and (b) of this article.

18.6 The Contractor shall promptly notify the Owner in writing of the causes of the delay. The Owner shall ascertain the facts and extent of the delay and notify the Contractor within a reasonable time of his decision in the matter.

19. Defective Work. Defective work shall be processed as follows:

19.1 The Contractor shall promptly remove from the premises all materials and work condemned by the Engineer as failing to meet Contract requirements, whether incorporated in the work or not, and the Contractor shall promptly replace and re-execute his own work in accordance with the Contract and without expense to the Owner and shall bear the expense of making good all work of other Contractors which was destroyed or damaged by such removal or replacement.

19.2 All removal and replacement work shall be done at the Contractor's expense. If the Contractor does not take action to remove such condemned work and materials within10 days after receipt of written notice, the Owner may remove them and store the material at the expense of the Contractor. If the Contractor does not pay the expense of such removal and storage within 10 days time thereafter, the Owner may, upon 10 days written notice, sell such materials at auction or at private sale and shall pay to the Contractor any net proceeds thereof, after deducting all the costs and expenses that should have been borne by the Contractor.

20. Differing Site Conditions. Claims for differing site conditions shall be processed as follows:

20.1 The Contractor shall promptly and before such conditions are disturbed, notify the Engineer in writing of:

a. Subsurface or latent physical conditions at the site differing materially from those indicated in this Contract; or,

b. Unknown physical conditions at the site, differing materially from those ordinarily encountered and generally recognized as inherent in the type of work provided for in this Contract.

20.2 The Engineer shall promptly investigate the conditions. If he finds that conditions differ materially and will cause an increase or decrease in the Contractor's cost or the time required to perform any part of the work under this Contract whether or not changed as a result of such conditions, the Engineer will notify the Owner and recommend an equitable adjustment. Contractor and Owner will enter into negotiations via the Engineer to modify the contact in writing.

20.3 No claim of the Contractor under this clause shall be allowed unless the Contractor has given proper notice as required in paragraph 20.1 of this clause.

20.4 No claim by the Contractor for an equitable adjustment shall be allowed if asserted after final payment under this Contract.

21. Claims For Extra Cost. Claims for extra cost shall be processed as follows:

21.1 No claim for extra work or cost shall be allowed unless the same was done pursuant to a written order by the Engineer, approved by the Owner and the claim presented for payment with the first estimate after the changed or extra work is done. When work is performed under the terms of article 17, the Contractor shall furnish satisfactory bills, payrolls and vouchers covering all items of cost when requested by the Owner and shall allow the Owner access to accounts relating thereto.

21.2 If the Contractor claims that any instructions by drawings or similar documents issued after the date of the Contract involve extra cost under the Contract, he shall give the Engineer written notice after the receipt of such instruction and before proceeding to execute the work, except in an emergency which threatens life or property, then the procedure shall be as provided for under article 17, “Extra Work & Change Orders.” No claim shall be valid unless so made.

22. Right of Owner to Terminate Contract.

22.1 In the event that any of the provisions of this Contract are violated by the Contractor, or by any of his Subcontractors, the Owner may serve written notice upon the Contractor and the surety of its intention to terminate the Contract, and unless within 10 days after the serving of such notice upon the Contractor, such violation or delay shall cease and satisfactory arrangement for correction be made, the Contract shall, upon the expiration of said 10 days cease and terminate. In the event of any such termination, the Owner shall immediately serve notice thereof upon the surety and the Contractor and the surety shall have the right to take over and perform the Contract; provided, however, that if the surety does not commence performance thereof within 10 days from the date of the mailing to such surety of notice of termination, the Owner may take over the work and prosecute the same to completion by Contract or by force account for the account and at the expense of the Contractor and the Contractor and his surety shall be liable to the Owner for any excess cost occasioned the Owner thereby, and in such event the Owner may take possession of and utilize in completing the work, such materials, appliances, and plant as may be on the site of the work and necessary therefore.

22.2 If the Contractor should be adjudged bankrupt, or if he should make a general assignment for the benefit of his creditors, or if a receiver should be appointed on account of his insolvency, or if he should refuse or should fail, except in cases for which extensions of time are provided, to supply enough skilled workmen or materials, or if he should fail to make payments to Subcontractors or for material or labor, so as to affect the progress of the work, or be guilty of a violation of the Contract, then the Owner, upon the written notice of the Engineer that sufficient cause exists to justify such action may, without prejudice to any other right or remedy and after giving the Contractor and his surety 7 days' written notice, terminate the employment of the Contractor and take possession of the premises and of all materials, tools, equipment and other facilities installed on the work and paid for by the Owner, and finish the work by whatever method he may deem expedient. In the case of termination of this Contract before completion from any cause whatever, the Contractor, if notified to do so by the Owner, shall promptly remove any part or all of his equipment and supplies at the expense of the Contractor. If such expense exceeds such unpaid balance, the Contractor shall pay the difference to the Owner. The expense incurred by the Owner as herein provided, and the damage incurred through the Contractor's default, shall be approved by the Engineer.

22.3 Where the Contract has been terminated by the Owner, said termination shall not affect or terminate any of the rights of the Owner as against the Contractor or his surety then existing or which may thereafter accrue because of such default. Any retention or payment of monies by the Owner due the Contractor under the terms of the Contract, shall not release the Contractor or his surety from liability for his default.

22.4 After ten (10) days from delivery of a Written Notice to the Contractor and the Engineer, the Owner may, without cause and without prejudice to any other remedy, elect to abandon the Project and terminate the Contract. In such case the Contractor shall be paid for all Work executed and any expense sustained plus reasonable profit.

22.5 If through no act or fault of the Contractor, the work is suspended for a period of more than ninety (90) days by the Owner or under an order of court or other public authority, or the Engineer fails to act on any request for payment within thirty (30) days after approved by the engineer, or the Owner fails to pay the Contractor substantially the sum approved by the Engineer or awarded by arbitrators within thirty (30) days of its approval and presentation, then the Contractor may, after ten (10) days from delivery of a Written Notice to the Owner and the Engineer terminate the Contract and recover from the Owner payment for all Work executed and all expenses sustained. In addition and in lieu of terminating the Contract, if the Engineer has failed to act on a request for payment or if the Owner has failed to make any payment as aforesaid, the Contractor may upon ten (10) days written notice to the Owner and the Engineer stop the Work until paid all amounts then due, in which event and

upon resumption of the Work Change Orders shall be issued for adjusting the Contract Price or Extending the Contract Time or both to compensate for the costs and delays attributable to the stoppage of the work.

22.6 If the performance of all or any portion of the Work is suspended, delayed, or interrupted as a result of failure of the Owner or Engineer to act within the time specified in the Contract Documents, or if no time is specified, within a reasonable time, an adjustment in the Contract Price or an extension of the Contract Time, or both, shall be made by Change Order to compensate the Contractor for the costs and delays necessarily caused by the failure of the Owner or Engineer.

23. Construction Schedule and Periodic Estimates shall provide for the following:

23.1 Before starting the work or upon request by the Engineer during its progress, the Contractor shall submit to the Engineer a work plan showing construction methods and the various steps he intends to take in completing the work.

23.2 Before the first partial payment is made, the Contractor shall prepare and submit to the Engineer:

a. A written schedule fixing the dates for submission of drawings; and

b. A written schedule fixing the respective dates for the start and completion of segments of the work. Each such schedule shall be subject to review and change during the progress of the work.

c. Respective dates for submission of Shop Drawings and for the beginning of manufacture, the testing, and the installation of materials, supplies, and equipment.

d. A schedule of payments that the Contractor anticipates will be earned during the course of the Work.

24. Payments to Contractor. Payments to the Contractor shall be made as follows:

24.1 Progress payments. The Owner will once each month make a progress payment to the Contractor on the basis of an estimate of the total amount of work done to the time of the estimate and its value as prepared by the Contractor and approved by the Engineer.

24.2 Retainage by Owner. The Owner will retain a portion of the progress payment, each month, in accordance with the following procedures:

a. The Owner will establish an escrow account in the bank of the Owner's choosing. The account will be established such that interest on the principal will be paid to the Contractor. The principal will be the accumulated retainage paid into the account by the Owner. The principal will be held by the bank, available only to the Owner, until termination of the Contract.

b. Until the work is 50% complete, as determined by the Engineer, retainage shall be 10% of the monthly payments claimed. The computed amount of retainage will be deposited in the escrow account established above.

c. After the work is 50% complete, and provided the Contractor has satisfied the Engineer in quality and timeliness of the work, and provided further that there is no specific cause for withholding additional retainage no further amount will be withheld. The escrow account will remain at the same balance throughout the remainder of the project, unless drawn upon by the Owner in accordance with articles 19, 22, and 56.

d. Upon substantial or final completion (as defined in article 25), the amount of retainage will be reduced to 2% of the total Contract Price plus an additional retainage based on the Engineer's estimate of the fair value of

the punch list items and the cost of completing and/or correcting such items of work, with specified amounts for each incomplete or defective item of work. As these items are completed or corrected, they shall be paid for out of the retainage until the entire project is declared completed (See article 25). The final 2% retainage shall be held during the one-year warranty period and released only after the Owner has accepted the project.

24.3 In reviewing monthly estimates for payments of the value of work done, the Engineer may accept in the estimate, prior to subtracting the retainage, the delivered cost of certain equipment and nonperishable material which have been delivered to the site or off-site location and which are properly stored and protected from damage. With the estimate, the Contractor shall submit to the Engineer invoices as evidence that the material has been delivered to the site. Prior to submitting the next monthly estimate, the Contractor shall provide the Engineer with paid invoices or other evidence that the materials have been paid for. If the Contractor fails to submit such evidence, the Engineer may then subtract the value of such materials or equipment for which the Owner has previously paid, from the next monthly estimate. The type of equipment and material eligible for payment prior to being incorporated in the work will be at the Engineer's discretion. Material and equipment made specifically for the subject job will be eligible for payment.

24.4 All material and work for which partial payments have been made shall thereupon become the sole property of the Owner. This provision shall not be construed as relieving the Contractor from the sole responsibility for the care and protection of materials and work upon which payments have been made or for the restoration of any damaged work, or as a waiver of the right of the Owner to require compliance with all of the terms of the Contract.

24.5 Owner's right to withhold payments and make application. The Contractor agrees that he will indemnify and save the Owner or the Owner's agents harmless from all claims growing out of the lawful demands of Subcontractors, laborers, workmen, mechanics, material men, and furnishers of machinery and parts, equipment, power, tools and all supplies, including commissary, incurred in the furtherance of the performance of this Contract. The Contractor shall, at the Owner's request, furnish satisfactory evidence that all claims of the nature hereinabove designated have been paid, discharged, or waived. If the Contractor fails to do so, then the Owner may, upon written notice to the Contractor either pay unpaid bills of which the Owner has written notice directly, or withhold from the Contractor's unpaid compensation a sum of money to pay any and all such lawful claims until satisfactory evidence is furnished that all liabilities have been fully discharged. Payment to the Contractor shall then be resumed in accordance with the terms of this Contract but in no event shall the above provisions be construed to impose any obligations upon the Owner to either the Contractor or his surety or any third party. In paying any unpaid bills of the Contractor, the Owner shall be deemed the agent of the Contractor, and any payment so made by the Owner shall be considered as payment made under Contract by the Owner to the Contractor and the Owner shall not be liable to the Contractor for any such payments made in good faith.

24.6 If the Owner fails to make payment forty-five (45) days after approval by the Engineer, in addition to other remedies available to the Contractor, there shall be added to each such payment interest at an annual rate of 10% commencing on the first day after said payment is due and continuing until the payment is received by the Contractor.

25. Acceptance and Final Payment provisions shall be as follows:

25.1 Substantial completion and payment.

a. Substantial completion shall be that point, as certified by the Engineer, at which the Contract or specified part thereof, has been completed to the extent that the Owner may occupy and/or make use of the work

performed for the purposes for which it was intended. Upon substantial completion there may be minor items, such as seeding, landscaping, etc., yet to be completed or items of work to be corrected.

b. Upon receipt of written notice from the Contractor that the work is substantially complete, the Engineer shall promptly make an inspection, and when he finds the work complies with the terms of the Contract and the Contract is substantially completed, he will issue a signed and dated certificate, and a list of all items to be completed or corrected, stating that the work required by this Contract has been substantially completed and is accepted by him.

c. Upon substantial completion, the entire balance due and payable to the Contractor less 2 percent of the Contract Price, and less a retention based on the Engineer's estimate of the fair value for the cost of completing or correcting listed items of work with specified amounts for each incomplete or defective item of work shall be made.

d. The general guarantee period for the work shall begin on the date certified by the Engineer that the work is substantially completed.

25.2 Final completion shall be that point at which all work has been completed and all defective work has been corrected. Unless the Engineer has issued a certificate of substantial completion, the general guarantee period shall begin upon certification by the Engineer of final completion.

25.3 At the end of the general guarantee period for the entire Contract which has been certified finally completed or substantially completed, the Owner, through the Engineer, shall make a guarantee inspection of all or portions of the work. When it is found that the work is satisfactory and that no work has become defective under the terms of the Contract, the Owner will accept the entire project and make final payment, including the reimbursement of monies retained pursuant to the guarantee period.

25.4 If the guarantee inspection discloses any work as being unsatisfactory, the Engineer will give the Contractor the necessary instructions for correction of such work, and the Contractor shall immediately execute such instructions. Upon correction of the work, another inspection will be made which shall constitute the guarantee inspection, provided the work has been satisfactorily completed.

25.5 Before issuance of final payment, the Contractor shall certify in writing to the Engineer that all payrolls, material bills, and other indebtedness connected with the work have been paid or otherwise satisfied; except that in case of disputed indebtedness or liens, if the Contract does not include a payment bond, the Contractor may submit in lieu of certification of payment a surety bond in the amount of the disputed indebtedness or liens, guaranteeing payment of all such disputed amounts, including all related costs and interest in connection with said disputed indebtedness or liens which the Owner may be compelled to pay upon adjudication.

25.6 If upon substantial completion, full completion is delayed through no fault of the Contractor, and the Engineer so certifies, the Owner may, upon certificate of the Engineer, and without termination of the Contract, make payment of the balance due for that portion of the work fully completed and accepted. Such payment shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of claims.

25.7 The acceptance by the Contractor of final payment shall release the Owner from all claims and all liability to the Contractor for all things relating to this work and for every act and neglect of the Owner and others relating to or arising out of this work. No payment, however, final or otherwise, shall operate to release the Contractor or his sureties from any obligations of the performance and payment bond under this Contract.

26. Payments by Contractor. The Contractor shall pay the costs:

26.1 For all transportation and utility services not later than the 20th day of the calendar month following that in which services are rendered;

26.2 For all materials, tools, and other expendable equipment to the extent of 90 percent of the cost thereof, not later than the 20th day of the calendar month following that in which such materials, tools and equipment are delivered at the site of the work and the balance of the cost thereof not later than the 30th day following the completion of that part of the work in or on which such materials, tools and equipment are incorporated or used; and

26.3 To each of his Subcontractors, not later than the 5th day following each payment to the Contractor, the respective amounts allowed the Contractor on account of the work performed by his Subcontractors to the extent of each Subcontractor's interest therein.

27. Insurance. The Contractor and any Subcontractor shall obtain all the insurance required under this article and such insurance shall be approved by the Owner.

27.1 The Contractor and all Subcontractors shall procure and shall maintain during the life of this Contract workmen's compensation insurance as required by applicable state law. The Contractor shall provide and shall cause each Subcontractor to provide adequate employer's liability insurance.

Limits of Liability: $100,000 each accident;
$500,000 disease - policy limit;
$100,000 disease - each employee.

27.2 The Contractor shall procure and shall maintain during the life of this Contract Commercial General liability insurance to include Contractual liability, explosion, collapse and underground coverages.

Limits of liability: $1,000,000 each occurrence bodily injury and property damage;
$2,000,000 general aggregate-include per project aggregate endorsement;
$2,000,000 products/completed operations aggregate.

If blasting or demolition or both is required by the Contract, the Contractor or Subcontractor shall obtain the respective coverage and shall furnish the Engineer a certificate of insurance evidencing the required coverages prior to commencement of any operations involving blasting or demolition or both.

27.3 The Contractor shall procure and shall maintain during the life of this Contract comprehensive automobile liability insurance to include all motor vehicles including owned, hired, borrowed and non-owned vehicles. Limits of liability: $1,000,000 combined single limit for bodily injury and property damage.

27.4 The Contractor shall either:

a. Require each of his Subcontractors to procure and to maintain during the life of his subcontract commercial general liability insurance and comprehensive automobile liability insurance of the type and in the amounts specified in articles 27.2 and 27.3; or

b. Insure the activities of his Subcontractors in his policy.

27.5 The required insurance shall provide adequate protection for the Contractor and his Subcontractors, respectively, against damage claims which may arise from work under this Contract, whether such work be by the insured or by anyone employed by him and also against any of the special hazards which may be encountered in the performance of this Contract.

27.6 The Contractor shall furnish the Owner with certificates showing the type, amount, class of operations covered, effective dates and dates of expiration of policies. Such insurance shall not be canceled or materially altered, except after 10 days written notice has been received by the Owner.

27.7 For builder's risk insurance (fire and extended coverage) and until the work is completed and accepted by the Owner, the Contractor is required to maintain builder's risk type insurance on a 100 percent completed value basis on the insurable portion of the work for the benefit of the Owner, the Contractor, and Subcontractors as their interests may appear.

27.8 The Contractor shall take out and furnish to the Owner and maintain during the life of this Contract, complete Owner's protective liability insurance.

Limits of Liability: $1,000,000 each occurrence;
$2,000,000 aggregate.

28. Contract Security. The Contractor shall within ten (10) days after the receipt of the Notice of Award furnish the Owner with a performance bond and a payment bond in penal sums equal to the amount of the Contract price conditioned upon the performance by the Contractor of all undertakings, covenants, terms, conditions and agreements of the Contract Documents, and upon the prompt payment by the Contractor to all persons supplying labor and materials in the prosecution of the Work provided by the Contract Documents. Such Bonds shall be executed by the Contractor and a corporate bonding company licensed to transact business in the state in which the Work is to be performed and named on the current list of "Surety Companies Acceptable on Federal Bonds" as published in the Treasury Department Circular Number 570. The expense of these Bonds shall be borne by the Contractor.

29. Additional or Substitute Bond. If at any time a surety on any such Bond is declared as bankrupt or loses its right to do business in the state in which the Work is to be performed, or is removed from the list of Surety Companies accepted on Federal Bonds, the Contractor shall within ten (10) days after notice from the Owner to do so, substitute an acceptable bond (or bonds) in such form and sum and signed by such other surety or sureties as may be satisfactory to the Owner. The premiums on such bond shall be paid by the Contractor. No further payments shall be deemed due nor shall be made until the new surety or sureties shall have furnished such an acceptable bond to the Owner.

30. Assignments. The Contractor shall not assign the whole or any part of this Contract or any monies due or to become due hereunder without written consent of the Owner. In case the Contractor assigns all or any part of any monies due or to become due under this Contract, the instrument of assignment shall contain a clause substantially to the effect that it is agreed that the right of the assignee in and to any monies due or to become due to the Contractor shall be subject to prior claims of all persons, firms and corporations for services rendered or materials supplied for the performance of the work called for in this Contract.

31. Mutual Responsibility of Contractors. If, through acts of neglect on the part of the Contractor, any other Contractor or any Subcontractor shall suffer loss or damage on the work site, the Contractor agrees to settle with such other Contractor or Subcontractor by agreement or arbitration if such other Contractor or Subcontractors will so settle. If such other Contractor or Subcontractors shall assert any claim against the Owner on account of any damage alleged to have been sustained, the Owner shall notify the Contractor, who shall indemnify and save harmless the Owner against any such claim.

32. Subcontracting. When subcontracting, the Contractor:

32.1 May utilize the services of specialty Subcontractors on those parts of the work which, under usual Contracting practices, are performed by specialty Subcontractors.

32.2 Shall be as fully responsible to the Owner for the acts and omissions of his Subcontractors, and of persons either directly or indirectly employed by them, as he is for the acts and omissions of persons directly employed by him.

32.3 Shall cause appropriate provisions to be inserted in all subcontracts relative to the work to bind Subcontractors to the Contractor by the terms of the Contract Documents insofar as applicable to the work of Subcontractors and to give the Contractor the same power as regards terminating any subcontract that the Owner may exercise over the Contractor under any provision of the Contract Documents.

32.4 Shall not create any Contractual relation between any Subcontractor and the Owner.

32.5 Shall not award Work to Subcontractor(s), in excess of fifty percent (50%) of the Contract Price, without prior written approval of the Owner.

33. Authority of the Engineer. In performing his duties, the Engineer or his representative shall:

33.1 Have the authority to suspend the work in whole or in part for such periods as he may deem necessary due to the failure of the Contractor to carry out provisions of the Contract or for failure of the Contractor to suspend work in weather conditions considered by the Engineer to be unsuitable for the prosecution of the work. The Engineer shall give all orders and directions under this Contract, relative to the execution of the work. The Engineer shall determine the amount, quality, acceptability, and fitness of the several kinds of work and materials which are to be paid for under this Contract and shall decide all questions which may arise in relation to the work. The Engineer's estimates and decisions shall be final and conclusive, except as otherwise provided. In case any question shall arise between the parties hereto relative to said Contract or specifications, the determination or decision of the Engineer shall be a condition precedent to the right of the Contractor to receive any money or payment for work under this Contract affected to any extent by such question. The Engineer shall decide the meaning and intent of any portion of the specifications and of any plans or drawings where the same may be found unclear. Any differences or conflicts in regard to their work which may arise between the Contractor under this Contract and other Contractors performing work for the Owner shall be adjusted and determined by the Engineer.

a. The purpose of the above article is not in any way to relieve the Contractor of his responsibilities for the safety of workmen or general public in the execution of the work. Attention is drawn to Article 13 of these Conditions which refers to the safety obligations of the Contractor.

b. The Engineer, acting on behalf of the Owner, has the authority to enforce corrective action for work not in accordance with the specifications.

c. In addition, the Engineer, acting on behalf of the Owner, is to ensure that the work is in accordance with the Contract Documents. He is not held responsible, however, for the methods of construction, sequences, schedules and procedures in the execution of the work. The Engineer does have the opportunity under 33.1 to reject the method of construction, work plan schedule, procedures, as he thinks appropriate.

33.2 Appoint assistants and representatives as he desires, and they shall be granted full access to the work under the Contract. They have the authority to give directions pertaining to the work, to approve or reject materials, to suspend any work that is being improperly performed, to make measurements of quantities, to keep records of

costs, and otherwise represent the Engineer in all matters except as provided below. The Contractor may, however, appeal from their decision to the Engineer himself, but any work done pending its resolution is at the Contractor's own risk. Except as permitted and instructed by the Engineer, the assistants and representatives are not authorized to revoke, alter, enlarge, relax, or release any requirements of these specifications, nor to issue instructions contrary to the plans and specifications. They are not authorized to act as superintendents or foremen for the Contractor, or to interfere with the management of the work by the Contractor. Any advice which the assistants or representatives of the Engineer may give the Contractor shall not be construed as binding the Engineer or the Owner in any way, nor as releasing the Contractor from the fulfillment of the terms of the Contract. All transactions between the Contractor and the representatives of the Engineer which are liable to protest or where payments are involved shall be made in writing.

34. Stated Allowances. The Contractor shall include in his proposal for costs of materials not shown in his bid under "cash allowances" or "allowed materials," any cash allowances stated in the supplemental general conditions or other Contract Documents. The Contractor shall purchase the "allowed materials" as directed by the Owner on the basis of the lowest and best bid of at least 3 competitive bids. If the actual price for purchasing the "allowed materials" is more or less than the "cash allowance," the Contract price shall be adjusted accordingly. The adjustment in Contract price shall be made on the basis of the purchase price without additional charges for overhead, profit, insurance or any other incidental expenses. The cost of installation of the "allowed materials" shall be included in the applicable sections of the Contract specifications covering this work.

35. Use of Premises, Removal of Debris, Sanitary Conditions. In the use of premises or removal of debris, the Contractor expressly undertakes at his own expense: to take every precaution against injuries to persons or damage to property; to maintain sanitary conditions; to store his apparatus, materials, supplies and equipment in such orderly fashion at the site of the work as will not interfere with the progress of his work or the work of any other Contractors; to place upon the work or any part thereof only such loads as are consistent with the safety of that portion of the work; to clean up frequently all refuse, rubbish, scrap materials and debris caused by his operations, to the end that at all times the site of the work shall present an orderly and workmanlike appearance; before final payment to remove all surplus material falsework, temporary structures, including foundations thereof, plant of any description and debris of every nature resulting from his operations, and to put the site in an orderly condition; to effect all cutting, fitting or patching of his work required to make the same conform to the plans and specifications and, except with the consent of the Engineer, not to cut or otherwise alter the work of any other Contractor; to provide and maintain in a sanitary condition such toilet accommodations for the use of his employees as may be necessary to comply with the requirements of the state and local boards of health, or of other bodies or authorities having jurisdiction.

36. Quantities of Estimate. Wherever the estimated quantities of work to be done and materials to be furnished under this Contract are shown in any of the documents including the proposal, they are given for use in comparing bids and the right is specifically reserved except as herein otherwise specifically limited, to increase or decrease them as may be deemed reasonably necessary by the Owner to complete the work contemplated by this Contract, and such increase or decrease shall in no way invalidate this Contract, nor shall any such increase or decrease give cause for claims or liability for damages. Such increases or decreases shall not exceed 25 percent of the estimated quantities of work. An increase or decrease in quantities for subsurface materials (e.g. ledge, unsuitable backfill), which overrun or underrun by 25% or more of the bid quantity may be the basis for a Contract price adjustment, at the rate of a negotiated adjusted unit rate. Negotiated unit price rates shall be equitable and shall take into account, but not be limited to the following factors; bid unit rate, distribution of rates and bid balance, and the scope of work as affected by the changed quantities. Claims for extra work resulting from changed quantities shall be processed under article 21.

37. Lands and Rights-of-Way. Acquisition and usage of lands and rights-of-way shall be as follows:

37.1 Prior to issuing the Notice to Proceed, the Owner shall legally obtain all lands and rights-of-way necessary for carrying out and completing the work to be performed under this Contract.

37.2 The Contractor shall not (except after written consent from the Owner) enter or occupy with men, tools, materials, or equipment, any land outside the rights-of-way or property of the Owner. A copy of the written consent shall be given to the Engineer.

37.3 The Owner shall provide to the Contractor information which delineates and describes the lands owned and the rights-of-way acquired.

37.4 The Contractor shall provide at its own expense and without liability to the Owner any additional land and access thereto that the Contractor may desire for temporary construction facilities, or for storage of materials.

38. General Guarantee. With reference to warranties, neither the final certificate of payment nor any provision in the Contract Documents, nor partial or entire occupancy of the premises by the Owner, shall constitute an acceptance of work not done in accordance with the Contract Documents or relieve the Contractor of liability in respect to any express warranties or responsibility for faulty materials or workmanship. The Contractor shall remedy any defects in the work and pay for any damage to other work resulting therefrom, which appear within the warranty period one year or longer if required by the Contract, from the certified date of completion or substantial completion of the work. The Owner will give notice of observed defects within two working days of their discovery.

39. Errors and Inconsistencies. With reference to errors and inconsistency in Contract Documents, any provisions in any of the Contract Documents which may be in conflict with the paragraphs in these general conditions shall be subject to the following order of precedence for interpretation:

39.1 Drawings will govern technical specifications.

39.2 General conditions will govern drawings and technical specifications.

39.3 Supplemental general conditions will govern general conditions, drawings and technical specifications.

39.4 Special conditions will govern supplemental general conditions, general conditions, drawings and technical specifications.

39.5 The Contractor shall take no advantage of any apparent error or omission in the plans or specifications. In the event the Contractor discovers such an error or omission, he shall notify the Engineer. The Engineer will then make such corrections and interpretations as may be deemed necessary for fulfilling the intent of the plans and specifications.

39.6 Figure dimensions on Drawings shall govern over general drawings.

40. Notice and Service Thereof. Any notice to the Contractor from the Owner relative to any part of this Contract will be in writing and will be considered delivered and the service completed, when said notice is mailed, by certified registered mail, to the Contractor at his last given address, or delivered in person to the Contractor or his authorized representative on the work.

41. Required Provisions Deemed Inserted. Each and every provision of law and clause required by law to be inserted in this Contract shall be deemed to be inserted herein and the Contract shall be read and enforced as though it were included herein, and if through mistake or otherwise any such provision is not inserted or is not correctly

inserted (example; miswording, etc.), then upon the application of either party the Contract shall forthwith be physically amended to make such insertion or correction.

42. Protection of Lives and Health. The work under this Contract is subject to the safety and health regulations (CRF 29, part 1926, and all subsequent amendments) as promulgated by the U.S. Department of Labor on June 24, 1974. Contractors are urged to become familiar with the requirements of these regulations.

43. OSHA Construction Safety Program.

43.1 Pursuant to NHRSA 277:5-a, the Contractor shall provide an Occupational Health and Safety Administration (OSHA) 10-hour construction safety program for its on-site employees. All employees are required to complete the program prior to beginning work. The training program shall utilize an OSHA-approved curriculum. Graduates shall receive a card from OSHA certifying the successful completion of the training program.

43.2 Any employee required to complete the OSHA 10-hour construction safety program, and who cannot within 15 days provide documentation of completion of such program, shall be subject to removal from the job site.

43.3 The following individuals are exempt from the requirements of the 10-hour construction safety program: law enforcement officers involved with traffic control or jobsite security; flagging personnel who have completed the training required by the Department of Transportation; all relevant federal, state and municipal government employees and inspectors; and all individuals who are not considered to be on the site of work under the federal Davis-Bacon Act, including, but not limited to, construction and non-construction delivery personnel and non-trade personnel.

44. Equal Employment Opportunity. Under equal employment opportunity requirements and during the performance of this Contract the Contractor agrees to the following:

44.1 The Contractor will not discriminate against any employee or applicant for employment because of race, creed, color, national origin, or sex. The Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, creed, color, national origin, or sex. Such action shall include, but not be limited to, the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this nondiscrimination clause.

44.2 The Contractor will in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration for employment, without regard to race, creed, color, national origin, or sex.

44.3 The Contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other Contract or understanding, a notice to be provided advising the labor union or worker's representative of the Contractor's commitment under section 202 of executive order no. 11246 of September 24, 1965, and 11375 of October, 13, 1967, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

44.4 The Contractor will comply with all provisions of executive orders no. 11246 and 11375.

44.5 The Contractor will furnish all information and reports required by executive orders no. 11246 and 11375.

44.6 In the event of the Contractor's noncompliance with the nondiscrimination clauses of this Contract or with any of such rules, regulations, or orders, this Contract may be canceled, terminated, or suspended in whole or in part by the Owner or the Department of Labor and the Contractor may be declared ineligible for further government Contracts or federally-assisted construction, however, that in the event the Contractor becomes involved in, or is threatened with, litigation with a Subcontractor or vendor as a result of such direction by the Department of Labor, the Contractor may request the United States to enter into such litigation to protect the interests of the United States.

44.7 A breach of this article may be grounds for termination of this Contract and for debarment as provided in 29 CFR 5.6.

45. Interest of Federal, State or Local Officials. No federal, state or local official shall be admitted to any share or part of this Contract or to any benefit that may arise therefrom, but this provision shall not be construed to extend to this Contract if made with a corporation for its general benefit.

46. Other Prohibited Interests. No official of the Owner who is authorized in such capacity and on behalf of the Owner to negotiate, make, accept or approve, or to take part in negotiating, making, accepting, or approving any architectural, Engineering, inspection, construction or material supply Contract or any subcontract in connection with the construction of the project, shall become directly or indirectly interested personally in this Contract or in any part hereof. No officer, employee, architect, attorney, Engineer or inspector of or for the Owner who is authorized in such capacity and on behalf of the Owner to exercise any legislative, executive, supervisory or other similar functions in connection with the construction of the project, shall become directly or indirectly interested personally in this Contract or in any part thereof, any material supply Contract, subcontract, insurance Contract, or any other Contract pertaining to the project.

47. Use and Occupancy Prior to Acceptance. Use and occupancy of a portion or unit of the project, upon completion of that portion or unit, and before substantial completion of the project, shall be a condition of this Contract with the following provisions:

47.1 The Owner will make his request for use or occupancy to the Contractor in writing.

47.2 There must be no significant interference with the Contractor's work or performance of duties under the Contract.

47.3 The Engineer, upon request of the Owner and agreement by the Contractor, will make an inspection of the complete part of the work to confirm its status of completion.

47.4 Consent of the surety and endorsement of the insurance carrier must be obtained prior to use and/or occupancy by the Owner. Also, prior to occupancy, the Owner will secure the required insurance coverage on the building.

47.5 The Owner will have the right to exclude the Contractor from the subject portion of the project after the date of occupancy but will allow the Contractor reasonable access to complete or correct items.

47.6 The warranty period shall begin upon substantial completion.

48. Suspension of Work. The Owner may, at any time and without cause, suspend the work or any portion thereof for a period of not more than 90 days by notice in writing to the Contractor and the Engineer. The Owner shall fix the date on which work shall be resumed. The Contractor will be allowed an increase in the Contract price or an extension of the Contract time, or both, directly attributable to any suspension if he makes a claim therefore as provided in articles 17 and 21.

49. [Reserved]

50. [Reserved]

51. [Reserved]

52. Project Sign. Furnish and erect a sign at the project site to identify the project and to indicate that the State Government is participating in the development of the project. Place the sign in a prominent location as directed by the Engineer. Do not place or allow the placement of other advertising signboards at the project site or along rights-of-way furnished for the project work. See Exhibit 1 for details of construction.

53. [Reserved]

54. Public Convenience and Traffic Control requirements:

54.1 The Contractor shall at all times so conduct his work as to assure minimal obstruction to traffic. The safety and convenience of the general public and the residents along the work site route and the protection of property shall be provided for by the Contractor. The Contractor shall be responsible for timely notification to local residents before causing any interruptions of their access.

54.2 Fire hydrants and water holes for fire protection on or adjacent to the work site shall be kept accessible to fire apparatus at all times, and no obstructions shall be placed within 10 feet of any such facility. No footways, gutters, drain inlets, or portions of highways adjoining the work site shall be obstructed. In the event that all or part of a roadway is officially closed to traffic during construction, the Contractor shall provide and maintain safe and adequate traffic accessibility, satisfactory to the Engineer, for residences and businesses along and adjacent to the roadway so closed.

54.3 When the maintenance of traffic is considered by the Engineer to be minimal, the Contract may not show this work as a pay item. In such cases, the Contractor shall bear all expense of maintaining traffic over the sections of road undergoing improvement and of constructing and maintaining such approaches, crossings, intersections, and other features as may be necessary, without direct reimbursement.

55. Pre-Construction Conference. The Contractor shall not commence work until a pre-construction conference has been held at which representatives of the Contractor, Engineer, Division and Owner are present. The pre-construction conference shall be scheduled by the Engineer.

56. Maintenance During Construction.

56.1 The Contractor shall maintain the work during construction and until it is accepted by the Owner. This maintenance shall be continuous and effective work prosecuted day by day, with adequate equipment and forces, to the end that roads or structures are kept in satisfactory condition at all times.

56.2 All cost of maintenance during construction and before the work is accepted by the Owner shall be included in the unit prices bid on the various pay items and the Contractor shall not be paid an additional amount for such maintenance.

56.3 If the Contractor, at any time, fails to comply with the provisions above, the Engineer may direct the Contractor to do so. If the Contractor fails to remedy unsatisfactory maintenance within the time specified by the Engineer, the Engineer may immediately cause the project to be maintained and the entire cost of this maintenance will be deducted from money to become due the Contractor on this Contract.

57. Cooperation with Utilities.

57.1 The Owner will notify all utility companies, all pipe line owners, or other parties affected, and have all necessary adjustments of the public or private utility fixtures, pipe lines, and other appurtenances within or adjacent to the limits of construction made as soon as practicable.

57.2 Water lines, gas lines, wire lines, service connections, water and gas meter boxes, water and gas valve boxes, light standards, cableways, signals, and all other utility appurtenances within the limits of the proposed construction which are to be relocated or adjusted are to be moved by the owners of such utilities at their expense, except as may otherwise be provided for in the special conditions or as noted on the plans.

57.3 It is understood and agreed that the Contractor has considered in his bid all of the permanent and temporary utility appurtenances in their present or relocated positions as shown on the plans and as evident on the site, and that no additional compensation will be allowed for any delays, inconvenience, damage sustained by him due to any interference from such utility appurtenances or the operation of moving them.

57.4 The Contractor shall cooperate with the Owners of any underground or overhead utility lines in their removal and rearrangement operations in order that these operations may progress in a reasonable manner, that duplication of rearrangements may be reduced to a minimum, and that services rendered by those parties will be minimal.

57.5 In the event of interruption to a water or utility service as a result of accidental breakage or as a result of being exposed or unsupported, the Contractor shall promptly notify the proper authority and shall cooperate with said authority in the restoration of services. If water service is interrupted, repair work shall be continuous until the service is restored. No work shall be undertaken around fire hydrants until provisions for continued service have been approved by the local fire authority. If any utility service is interrupted for more than 4 hours, the Contractor shall make provisions for temporary service at his own expense until service is resumed.

58. Work Performed at Night and on Sundays and Holidays shall comply with the following:

58.1 No work will be permitted at night or on Sundays or holidays except as approved in writing by the Engineer, and provided such work is not in violation of a local ordinance. When working at night, the Contractor shall provide flood lighting sufficient to insure the same quality of workmanship and the same conditions regarding safety as would be achieved in daylight.

58.2 Whenever Memorial Day or Fourth-of-July is observed on a Friday or a Monday and during the weekend of Labor Day, the Contractor may be required to suspend work for the 3 calendar days. Prior to the close of work, the work site shall be placed in a condition acceptable to the Engineer for the comfort and safety of the traveling public. An arrangement shall be made for responsible personnel acceptable to the Engineer to maintain the project in the above conditions.

59. Laws to be Observed. With reference to laws that shall be observed:

59.1 The Contractor shall keep fully informed of all federal and state laws, all local laws, ordinances, and regulations, and all orders and decrees of tribunals having any jurisdiction or authority, which in any manner affect those engaged or employed on the work. He shall at all times observe and comply with all such laws, ordinances, regulations, orders, and decrees; and shall protect and indemnify the state and its representatives against any claim or liability arising from or based on the violation of any such law, ordinance, regulation, order, or decree, whether by himself or his employees.

59.2 Indemnification

The Contractor will indemnify and hold harmless the Owner and the Engineer and their agents and employees from and against all claims, damages, losses, and expenses including attorney's fees arising out of or resulting from the performance of the Work, provided that any such claims, damage, loss or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property including the loss of use resulting therefrom; and is caused in whole or in part by any negligent or willful act or omission of the Contractor, and Subcontractor, anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable.

In any and all claims against the Owner or the Engineer, or any of their agents of employees, by any employees of the Contractor, and Subcontractor, anyone directly or indirectly employed by any of them, or anyone for whose acts any of them may be liable, the indemnification obligation shall not be limited in any way by any limitation on the amount or type of damages, compensation or benefits payable by disability benefit or other employee benefit acts.

The obligation of the Contractor under this paragraph shall not extend to the liability of the Engineer, his agents or employees arising out of the preparation or approval of maps, Drawings, opinions, reports, surveys, Change Orders, designs or Specifications.

60. Permits. Permits to be obtained by the Contractor shall be in accordance with the following:

60.1 Permits and licenses of a temporary nature necessary for the prosecution of the work shall be obtained and paid for by the Contractor. Permits, licenses and easements for permanent structures or permanent changes in existing facilities will be secured and paid for by the Owner. Permits may include:

a. New Hampshire Department of Transportation Highway Trench Permits.

b. RSA 485-A:17 and 483-A N.H. DES Wetlands Bureau Dredge and Fill Permit.

c. RSA 485-A:17 - N.H. DES Site Specific Permit (Water Quality)

d. RSA 149-M:10 N.H. DES Solid Waste Management Bureau - disposal of construction debris and/or demolition waste.

e. N.H. Department of Environmental Services Air Resources Division (burning permits).

f. Other permits, as required by State and Local laws and ordinances.

g. Notice of intent for coverage under EPA's General NPDES Permit for construction dewatering activities.

61. Control of Pollution due to construction shall comply with the following:

61.1 During construction, the Contractor shall take precautions sufficient to avoid the leaching or runoff of polluting substances such as silt, clay, fuels, oils, bitumens, calcium chloride and any other polluting materials which are unsightly or which may be harmful to humans, fish, or other life, into groundwaters and surface waters of the State.

61.2 In waters used for public water supply or used for trout, salmon, or other game or forage fish spawning or nursery, control measures must be adequate to assure that turbidity in the receiving water will be increased not more than 10 standard turbidity units (s.t.u.) in the absence of other more restrictive locally-established limitations, unless otherwise permitted by the Division. In no case shall the classification for the surface water be violated.

61.3 In water used for other purposes, the turbidity must not exceed 25 s.t.u. unless otherwise permitted by the Division.

62. Use of Explosives.

62.1 When the use of explosives is necessary for the prosecution of the Work, exercise the utmost care not to endanger life or property. The Contractor shall be responsible for any and all damage resulting from the use of explosives.

62.2 Store all explosives in a secure manner, in compliance with all State and local laws and ordinances, and legally mark all such storage places. Storage shall be limited to such quantity as may be needed for the work underway.

62.3 Designate as a “Blasting Area” all sites where electric blasting caps are located and where explosive charges are being placed. Mark all blasting areas with signs as required by law. Place signs as required by law from each end of the blasting area and leave in place while the above conditions prevail. Immediately remove signs after blasting operations or the storage of caps is over.

62.4 Notify each property Owner and public utility company having structures in proximity to the site of the work sufficiently in advance to enable the companies to take such steps as they may deem necessary to protect their property. Such notice shall not relieve the Contractor of any of his responsibility for damage resulting from his blasting operation. Warn all persons within the danger zone of blasting operations and do not perform blasting work until the area is cleared. Provide sufficient flagmen outside the danger zone to stop all approaching traffic and pedestrians. Provide watchmen during the loading period and until charges have been exploded. Place adequate protective covering over all charges before being exploded.

63. Arbitration by Mutual Agreement.

63.1 All claims, disputes, and other matters in question arising out of, or relating to, the Contract Documents or the breach thereof, except for claims which have been waived by making an acceptance of final payment as provided in Section 25, may be decided by arbitration if the parties mutually agree. Any agreement to arbitrate shall be specifically enforceable under the prevailing arbitration law. The award rendered by the arbitrators shall be final, and judgment may be entered upon it in any court having jurisdiction thereof.

63.2 Notice of the request for arbitration shall be filed in writing with the other party to the Contract Documents and a copy shall be filed with the Engineer. Request for arbitration shall in no event be made on any claim, dispute, or other matter in question which would be barred by the applicable statute of limitations.

63.3 The Contractor will carry on the Work and maintain the progress schedule during any arbitration proceedings, unless otherwise mutually agreed in writing.

64. Taxes. The Contractor shall pay all sales, consumer, use, and other similar taxes required by the laws of the place where the Work is performed.

65 Separate Contracts.

65.1 The Owner reserves the right to let other Contracts in connection with this Project. The Contractor shall afford other Contractors reasonable opportunity for the introduction and storage of their materials and the execution of their Work, and shall properly connect and coordinate the Work with theirs. If the proper execution or results of any part of the Contractor's Work depends upon the Work of any other Contractor, the Contractor shall inspect

and promptly report to the Engineer any defects in such Work that render it unsuitable for such proper execution and results.

65.2 The Owner may perform additional Work related to the Project or the Owner may let other Contracts containing provisions similar to these. The Contractor will afford the other Contractors who are parties to such Contracts (or the Owner, if the Owner is performing the additional Work) reasonable opportunity for the introduction and storage of materials and equipment and the execution of the Work, and shall properly connect and coordinate the Work with theirs.

65.3 If the performance of the additional Work by other Contractors or the Owner is not noted in the Contract Documents prior to the execution of the Contract, written notice shall thereof be given to the Contractor prior to starting such additional Work. If the Contractor believes that the performance of such additional Work by the Owner or others involves it in additional expense or entitles it to an extension of the Contract Time, the Contractor may make a claim thereof as provided in Sections 17 and 18.

EXHIBIT 1

Project Sign Detail

[Insert project sign detail here - Contact NHDES for appropriate detail]

SPECIAL CONDITIONS

Supplements

The following supplements, modify, change, delete, or add to the General Conditions. Where any part of the General Conditions is modified or voided by these sections, the unaltered provisions of that part should remain in effect.

Section No.	Section Title	Page No.
SC-10	Surveys; Supplement to GC-10	C-2.2
SC-24	Retainage by Owner; Supplement to GC-24	C-2.2
SC-27	Insurance; Supplement to GC-27	C-2.2
SC-49	Nondiscrimination in City Contracts	C-2.3
SC-52	Project Sign; Supplement to GC-52	C-2.3
SC-58	Work Performed at Night and on Sundays and Holidays; Supplement to GC-58	C-2.3
SC-60	Permits	C-2.4
SC-62	Use of Explosives	C-2.4

SPECIAL CONDITIONS

SC-10 SURVEYS (SUPPLEMENT TO GC10)

Add paragraph 10.5:
As follows:

10.5 The Engineer's layout of structures and pipelines will be general in nature to be adjusted by the Contractor based on location of other utilities as determined by the Contractor. All adjustments shall be approved by Engineer and Owner.

SC-24 RETAINAGE BY OWNER

Delete paragraph 24.2 in its entirety and **replace** with the following:

24.2 Retainage by Owner. The Owner will retain a portion of the progress payment, each month, in accordance with the following procedures:

a. Until the work is 50% complete, as determined by the Engineer, retainage shall be 10% of the monthly payments claimed.

b. After the work is 50% complete, and provided the Contractor has satisfied the Engineer in quality and timeliness of the work, and provided further that there is no specific cause for withholding additional retainage no further amount will be withheld, and the retained amount will remain at the same balance throughout the remainder of the project, unless drawn upon by the Owner in accordance with articles 19, 22, and 58.

c. Upon substantial or final completion (as defined in article 25), the amount of retainage will be reduced to 2% of the total amount due the Contractor plus an additional retainage based on the Engineer's estimate of the fair value of the punch list items and the cost of completing and/or correcting such items of work, with specified amounts for each incomplete or defective item of work. As these items are completed or corrected, they shall be paid for out of retainage until the entire project is declared completed (See article 25). The final 2% retainage shall be held during the one-year warranty period and released only after the project has been accepted by the Owner.

SC-27 INSURANCE REQUIREMENTS

Add the following at the end of Paragraph 27.2 of the General Conditions:

Limits of liability for blasting or demolition or both shall be $5,000,000 of personal injury and property damage liability insurance covering the permitted blasting operations, or such an amount as may be determined necessary by extraordinary circumstances. The Certificate shall name the City as an additional insured.

Add the following after Paragraph 27.8 of the General Conditions:

27.9 The Contractor shall name the City of Portsmouth and the Engineer as an additional insured for their general liability and automobile liability policies. The City shall be listed as

follows:

City of Portsmouth
Attn: Legal Department
1 Junkins Avenue
Portsmouth, NH 03801

27.10 Umbrella or excess liability
Contractor shall purchase and maintain umbrella or excess liability insurance written over the underlying employer's liability, commercial general liability, and automobile liability insurance described in the paragraphs above. Subject to industry-standard exclusions, the coverage afforded shall follow form as to each and every one of the underlying policies.
Limits of Liability:
$5,000,000 per occurrence
$5,000,000 general aggregate

SC-49 NONDISCRIMINATION IN CITY CONTRACTS

Add paragraph 49.1 as follows:

49.1 Any entity that enters into a contract for goods or services with the City of Portsmouth or any of its boards, agencies, and departments and any recipient of city funds shall:

a) Implement an employment nondiscrimination policy prohibiting discrimination in hiring, discharging, promoting, or demoting, matters of compensation, or any other employment-related decision or benefit on account of actual or perceived race, ethnicity, color, religion, national origin, gender, disability, age, military status, sexual orientation, gender identity, gender expression, or marital or familial status.

b) Not discriminate in the performance of the contract on account of actual or perceived race, ethnicity, color, religion, national origin, gender, disability, age, military status, sexual orientation, gender identity, gender expression, or marital or familial status.

SC-52 PROJECT SIGN

Delete "See Exhibit 1 for details of construction".

Add "See Specification Section 01580 for details of construction".

SC-58 WORK PERFORMED AT NIGHT AND ON SUNDAYS AND HOLIDAYS

Add "Saturdays" to the Section Title and to Paragraph 58.1. **Add** the following sentence to the beginning of Paragraph:

"The Contractor's work hours shall be from 7:00 AM to 6:00 PM, Monday through Friday, unless authorized by the City of Portsmouth."

Add Paragraph 58.3.

"City Holidays includes New Year's Day, Dr. Martin Luther King Jr. Day, Presidents' Day, Good Friday, Memorial Day, Independence Day, Labor Day, Columbus Day, Veteran's Day, Thanksgiving Day, the Day after Thanksgiving Day, and Christmas Day.

SC-60 PERMITS

Add the following after Paragraph 60.1.g of the General Conditions:

h. Building Permit (to be obtained from the City of Portsmouth Building Inspector's Office; Code Enforcement).

i. Electrical Permit (to be obtained from the City of Portsmouth Building Inspector's Office; Code Enforcement).

k. Excavation Permit, Blasting Permit, Drain Layers Permit (to be obtained from the City of Portsmouth Public Works Department).

m. New Hampshire Department of Environmental Services Wetland Permit (See Appendix C of the Specifications).

n. The City will waive all City permitting fees for this project.

SC-62 USE OF EXPLOSIVES

Add paragraphs 62.5 and 62.6 as follows:

62.5 The Contractor shall be responsible for notifying the City of Portsmouth Fire Department prior to each blasting operation.

62.6 Refer to Specification Section 01546 for additional requirements related to the use of explosives.

END OF SECTION

SECTION 01010

SUMMARY OF WORK

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Construction of City of Portsmouth, New Hampshire Marjorie Street Pump Station. The major proposed work under this Contract includes:

1. Construction of:
   a. A complete functional submersible pump station;
   b. Pump station control cabinet with concrete pad;
   c. Temporary bypass pumping system;
   d. Wet well;
   e. Valve pit;
   f. Natural gas emergency generator with concrete pad;
   g. Instrumentation, control, and SCADA system;
   h. Approximately 1,000 LF of force main pipe;
   i. Piping, site work, equipment systems, structures, instrumentation, control and electrical systems, as indicated on the Drawings.
   j. Other appurtenances as shown on the Drawings and specified herein.
2. Maintain sewer flow conveyance as detailed in Part 3 of this section.
3. Remove and/or relocate equipment as indicated on the Drawings.

B. Related Work Specified Elsewhere:
1. Coordination: Section 01050
2. Construction Schedules: Section 01310.

C. Removals, Relocations and Rearrangements
1. Examine the existing site for the work of all trades which will influence the cost of the work under the bid. This work shall include removals, relocations and rearrangements which may interfere with, disturb, or complicate the performance of the work under the bid involving systems, equipment and related service lines, which shall continue to be utilized as part of the finished project. The Contractor is responsible for all coordination in this regard.
2. Provide in the bid a sufficient amount to include all removals, relocations, rearrangements, and reconnections herein specified, necessary or required to provide approved operation and coordination of the combined new and existing systems and equipment.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 MAINTAIN EXISTING WORKS

A. Existing Operations:

1. The existing sanitary sewer services the residential area of Lois Street, Marjorie Street, and Sylvester Street. Sewer flows from this service area are currently conveyed by gravity heading south via 8-inch asbestos cement pipe (ACP) to Greenleaf Avenue.
2. Typical raw sewerage flows from the project site are as follows:
    a. Average: 10-gpm;
    b. Peak Hour: 100-gpm;
    c. Contractor shall be required to convey the entire range of influent flows for the duration of the project until permanent conveyance is established.

B. Maintain Conveyance:

1. State and federal regulations require that at all times during construction work under this contract, the conveyance of raw wastewater shall remain operational throughout construction, until such time as the new facilities are accepted and on-line.
2. The Contractor shall provide, maintain and operate all temporary facilities such as dams, pumping equipment, conduits, and all other labor and equipment necessary to intercept the sewage flow before it reaches the points where it would interfere with the work, and carry it past the work such that essential treatment processes remain operational and effective.
3. The Contractor's operations shall not hinder the delivery, storage and use of materials and supplies, nor hinder staff duties, nor disrupt utility service.
4. The Owner must have access to the existing sanitary sewer at all times unless a specific exception is granted by the Owner.

C. Minimize Interference

1. The Contractor shall at all times conduct their operations so as to interfere as little as possible with existing works. This program shall be adhered to except as deviations therefrom are expressly permitted.
2. Work of connecting with, cutting into, and reconstructing existing pipes or structures shall be planned to interfere with the operation of the existing facilities for the shortest possible time and when the demands on the facilities best permit such interference. It may be necessary to work outside of normal working hours to minimize interference. Before starting work which will interfere with the operation of existing facilities, the Contractor shall do all possible preparatory work and shall see that all tools, materials, and equipment are made ready and at hand.
3. There are no bathroom or kitchen facilities at the site.
4. The Contractor shall limit their personnel to the proposed work areas and limits of work.
5. The Contractor shall limit parking of workers and subcontractors to an area agreed upon by the Contract and Owner.

3.2 CONSTRUCTION SEQUENCE

A. The Contractor shall submit to the Engineer for review and acceptance a complete schedule of their proposed sequence of construction operations prior to commencing any work. This schedule shall include the Contractor's plans for doing the work.

B. The Contractor shall submit to the Engineer a written request to deviate from the above sequence with adequate supporting information to demonstrate to the Engineer that the continuity and degree of treatment will not be adversely affected.

C. The Contractor shall notify the Owner a minimum of seven (7) days in advance of any work which may affect or disrupt the operation of the existing facilities. Once the interruption occurs the Contractor must maintain a workforce on-site to complete the work in the agreed upon time.

D. The Contractor shall have all materials and equipment on-site, and shall receive the Owner's approval, prior to initiating work which requires any part of the existing wastewater treatment plant to be off-line.

E. Should the Contractor fail to complete the Work within the down-time specified and should the Owner incur any actual costs directly or indirectly as a result thereof that would otherwise not have incurred had the Contractor successfully completed the Work within the specified down-time, the Contractor agrees to pay the Owner such actual incurred costs. Such costs may include, but not be limited to, Owner's actual costs of any additional maintenance and operations labor, material, equipment, and chemical costs, or any other related actual costs incurred in order for the Owner to keep the existing plant in normal operating condition.

F. The Contractor shall include the cost of all temporary facilities required to maintain treatment during the construction period in their lump-sum bid price. The cost shall include the cost for all labor, tools, equipment, materials and temporary systems, as necessary.

END OF SECTION

SECTION 01050

COORDINATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Contractor is required to work in close proximity to Owner's existing facilities. The Contractor, under this Contract, will be responsible for coordinating construction activities with Owner to ensure that services, facilities, and safe working conditions are maintained.

B. Other Construction Contractors will be interfacing with this Contract and working within the work area and in the vicinity of this Contract. The Contractor, under this contract, shall act as Construction Coordinator and shall coordinate construction activities with other Contractors working for Owner.

C. Any damage to existing structures, equipment and property, accepted equipment or structures, and property or work in progress by others as a result of the Contractor's or their subcontractor's operations shall be made good by the Contractor at no additional cost to the Owner.

1.2 COORDINATION WITH OTHERS

A. City of Portsmouth:

1. Contractor shall coordinate access, egress, detours and traffic control, if required, at each site with the Portsmouth Police Department. The Contractor shall notify Portsmouth Police, Fire Rescue & Emergency Services at least 24 hours in advance of any street closings or detours.
2. Contractor shall coordinate all work on City property with the treatment plant personnel.
3. The Contractor shall be responsible for coordinating and maintaining public services to all public and private properties.

B. City of Portsmouth Public Works Water Department

1. Contractor shall be responsible for coordinating all work in the vicinity of water lines with the City of Portsmouth. Contractor shall bear all costs for the City's inspection requirements, temporary facilities, water main adjustments and other requirements.

C. Eversource (PSNH):

1. The Contractor shall be responsible for coordinating all work with Eversource and shall bear all costs of inspection requirements, temporary facilities relocation and other requirements.

D. Unitil

1. The Contractor shall be responsible for coordinating all work around Unitil facilities with Unitil and shall bear all costs of inspection requirements, temporary facilities relocation and other requirements.

E. Comcast/Xfinity:
   1. The Contractor shall be responsible for coordinating all work around Comcast/Xfinity facilities with Comcast/Xfinity and shall bear all costs of inspection requirements.

F. Consolidated Communications
   1. The Contractor shall be responsible for coordinating all work around Consolidated facilities with Consolidated and shall bear all costs of inspection requirements, temporary facilities relocation, and other requirements.

G. The Contractor shall provide the Resident Project Representative and Chief Operator a construction schedule indicating the times to perform the work required. The Contractor shall update the schedule when required and give the facility one week notice before the start of any work. The Contractor shall provide the facility personnel enough time to obtain materials and perform the work required of them. The Contractor shall daily communicate with the Resident Project Representative and Chief Operator concerning updating the schedule, job progress, delay or early starts that affect the treatment process, facility staffing, etc.

H. Weekly coordination meetings shall be held between the Contractor, Owner's Chief Operator/Superintendent and the Resident Project Representative. This meeting shall cover the following:
   1. Work to be completed the following week
   2. Project Schedule
   3. Shop Drawing and O&M issues
   4. Outstanding RFIs and Clarifications
   5. Change Orders and Field Orders
   6. Review of Record Drawing Information
   7. Discussion/Resolution of any old issues
   8. New issues discussion
   9. Contractor's Safety and Health Plan Updates

I. The Contractor shall be responsible for explicitly notifying all equipment suppliers, electrical subcontractor, and the instrumentation supplier that they are required to coordinate their work with the instrumentation supplier by providing operating sequences, input/out specifications with wiring diagrams for all equipment, and that they shall review and comment on each other's shop drawings to ensure that all interfaces are compatible.

J. Snow Removal Coordination: The Contractor shall be responsible for all snow removal activities in construction and laydown areas onsite.

1.3 CONTRACTOR'S USE OF PREMISES

A. Contractor shall have use of the premises within the limits shown on the Drawings and as defined in the General Conditions for the performance of the Work.

B. Contractor work hours will be limited to 7:00AM to 6:00PM, Monday through Friday . Any work outside these hours will require permission of the Owner and adequate notice.

C. Contractor shall coordinate delivery schedules, site access, and other construction-related activities with any other contractors that may be hired by the Owner during the course of construction.

D. Contractor shall assume full responsibility for security of all of their, and their subcontractors, materials and equipment stored on the site.
E. If directed by the Owner, Contractor shall move any stored items which interfere with operations of Owner.
F. Obtain and pay for use of additional storage or work areas if needed to perform the Work.
G. Contractor shall not have access to Owners lunchroom, toilet or locker room facilities at any time and shall provide all necessary facilities in accordance with Specification Section 01500.

END OF SECTION

SECTION 01070

ABBREVIATIONS & SYMBOLS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Where any of the following abbreviations are used in these Specifications, they shall have the meaning set forth opposite each.

AASHTO	American Association of State Highway and Transportation Officials
AC	Alternating Current
ACI	American Concrete Institute
ACP	Asbestos Cement Pipe
AGA	American Gas Association
AIC	Ampere Interrupting Capacity
AGMA	American Gear Manufacturers Association
AIEE(IEEE)	American Institute of Electrical Engineers (Institute of Electrical and Electronics Engineers, Inc.)
AISC	American Institute of Steel Construction
amp	Ampere 125-16
Amer. Std.	American Standard for Cast Iron Pipe Flanges and Flanged Fittings, Class l25 (ASA Bl6 ll960)
ANSI	American National Standards Institute
API	American Petroleum Institute
ASA	American Standards Association
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWG	American or Brown and Sharpe Wire Gage
AWWA	American Water Works Association
BOD	Biochemical Oxygen Demand
c.f.	Cubic Foot
c.f.m.	Cubic Foot Per Minute
c.f.s.	Cubic Foot Per Second
CI	Cast Iron
CIPRA	Cast Iron Pipe Research Association
CSI	Construction Specifications Institute
c.y.	Cubic Yards
DC	Direct Current
DEP	Department of Environmental Protection
DI	Ductile Iron
DOT	Department of Transportation
EDR	Equivalent Directional Radiation

EPA	U.S. Environmental Protection Agency
fps	Feet Per Second
ft.	Feet
gal.	Gallons
gpd	Gallons Per Day
gpm	Gallons Per Minute
HP	Horsepower
IBR	Institute of Boiler and Radiator Manufacturers
in.	Inches
inter.	Interlock
ISA	Instrument Society of America
kva	Kilovolt-ampere
kw	Kilowatt
lb.	Pound
max.	Maximum
MCB	Master Car Builders
MGD	Million Gallons Per Day
Min.	Minimum
NBS	National Bureau of Standards
NEC	National Electrical Code, Latest Edition
NEMA	National Electrical Manufacturers Association
NEWWA	New England Water Works Association
NPT	National Pipe Thread
OS&Y	Outside Screw and Yoke
PCA	Portland Cement Association
ppm	Parts Per Million
%	Percent
psi	Pounds Per Square Inch
psig	Pounds Per Square Inch Gage
PVC	Polyvinyl Chloride
rpm	Revolutions Per Minute
RUS	Rural Utility Service
s.f.	Square Foot
STL. W.G.	U.S. Steel Wire, Washburn and Moen, American Steel and Wire Cos., or Roebling Gage
s.y.	Square yard
TDH	Total Dynamic Head
USAS	Standards of the United States of America Standards Institute (formerly American Standards Association)
USS GAGE	United States Standard Gage
VC	Vitrified Clay
WSP	Working Steam Pressure
Fed. Spec.	Federal Specifications issued by the Federal Supply Service of the General Service Administration, Washington, D.C.

END OF SECTION

SECTION 01150

MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. For lump sum items, payment shall be made to the Contractor in accordance with an accepted Progress Schedule and Schedule of Values on the basis of actual work completed.

B. For unit-price items, payment shall be based on the actual amount of work accepted and for the actual amount of materials in place, as shown by the final measurements.

1. All units of measurement shall be standard United States convention as applied to the specific items of work by tradition and as interpreted by the Engineer.
2. At the end of each day's work, the Contractor's Superintendent or other authorized representative of the Contractor shall meet with the Resident Project Representative and determine the quantities of unit price work accomplished and/or completed during the work day.
3. The Resident Project Representative will then prepare two "Daily Progress Reports" which shall be signed by both the Resident Project Representative and Contractor's Representative.
4. Once each month the Resident Project Representative will prepare two "Monthly Progress Summation" forms from the month's accumulation of "Daily Progress Reports" which shall also be signed by both the Resident Project Representative and Contractor's Representative.
5. These completed forms will provide the basis of the Engineer's monthly quantity estimate upon which payment will be made. Items not appearing on both the Daily Progress Reports and Monthly Progress Summation will not be included for payment. Items appearing on forms not properly signed by the Contractor will not be included for payment.
6. After the work is completed and before final payment is made there for, the Engineer will make final measurements to determine the quantities of various items of work accepted as the basis for final settlement.

1.2 SCOPE OF PAYMENT

A. Payments to the Contractor will be made for the actual quantities of the Contract items performed and accepted in accordance with the Contract Documents. Upon completion of the construction, if these actual quantities show either an increase or decrease from the quantities given in the Bid Form, the Contract unit prices will still prevail.

B. The Contractor shall accept compensation, as herein provided, in full payment for furnishing all materials, labor, tools, equipment, and incidentals necessary to the completed work and for performing all work contemplated and embraced by the Contract; also for all loss or damage arising from the nature of the Work, or from the action of the elements, or from any unforeseen difficulties which may be encountered during the prosecution of the Work and until its final acceptance by the Engineer, and

for all risks of every description connected with the prosecution of the work, except as provided herein, also for all expenses incurred in consequence of the suspension of the work as herein authorized.

C. The payment of any partial estimate or of any retained percentage except by and under the approved final invoice, in no way shall affect the obligation of the Contractor to repair or renew any defective parts of the construction or to be responsible for all damage due to such defects.

1.3 PAYMENT FOR INCREASED OR DECREASED QUANTITIES

A. When alterations in the quantities of work not requiring supplemental agreements, as hereinbefore provided for, are ordered and performed, the Contractor shall accept payment in full at the Contract price for the actual quantities of work done. No allowance will be made for anticipated profits. Increased or decreased work involving supplemental agreements will be paid for as stipulated in such agreements.

1.4 OMITTED ITEMS

A. Should any items contained in the bid form be found unnecessary for the proper completion of the work contracted, the Engineer may eliminate such items from the Contract, and such action shall in no way invalidate the Contract, and no allowance will be made for items so eliminated in making final payment to the Contractor.

1.5 PARTIAL PAYMENTS

A. Partial payments shall be made monthly as the work progresses. Partial payment shall be made subject to the provisions of the Supplemental and General Conditions. Contractor's Partial Payment Requests shall be submitted in two parts; one part for EPA/DEP grant eligible quantities and one part for non-eligible quantities. The breakdown of quantities will be determined by the Engineer.

B. Technical Specifications may include Special Payment Provisions which provide additional restrictions on partial payments.

1.6 PAYMENT FOR MATERIAL DELIVERED

A. When requested by the Contractor and at the discretion of the Owner, payment may be made for all or part of the value of acceptable, non-perishable materials and equipment which are to be incorporated into bid items, have not been used, and have been delivered to the construction site or placed in storage places acceptable to the Owner. Payment shall be subject to the provisions of the General and Supplementary Conditions.

B. No payment shall be made upon fuels, supplies, lumber, false work, or other materials, or on temporary structures or other work of any kind which are not a permanent part of the Contract.

1.7 FINAL PAYMENT

A. The Engineer will make, as soon as practicable after the entire completion of the project, a final quantity invoice of the amount of the Work performed and the value of such Work. Owner shall make final payments of the sum found due less retainages subject to the provisions of the General and Supplementary Conditions.

1.8 INCIDENTAL WORK

A. Incidental work items for which separate payment is not made include (but are not limited to) the following items:

1. Clearing, grubbing and stripping
2. Dust control
3. Dewatering
4. Clean-up
5. Erosion control
6. Loam, seeding, grading, liming, fertilization, mulching and watering
7. Pipe bedding and backfill
8. Compaction testing of backfill
9. Restoration of property, and replacement of fences, curbs, structures, sign posts, guard rails, rock wall, mail boxes, traffic loop detectors and other minor items disturbed by the construction activities
10. Coordination with the Owner, Utilities and others, including related inspection cost (refer to Section 01050)
11. Utility crossings and relocations, unless payment is otherwise made
12. Project Signs
13. Trench boxes, steel and/or wood sheeting as required, including that left in place
14. Project record documents
15. Materials testing
16. Construction schedules, bonds, insurance, shop drawings, warranties, guarantees, certifications, and other submittals required by the Contract Documents
17. Repair and replacement of water lines under two inches in size, culverts, underdrains, rock lined drainage trenches in streets and other utilities damaged by construction activities and corresponding proper disposal of removed materials unless otherwise paid for
18. Cleaning, testing and disinfection of all water lines and appurtenances
19. Maintenance of all existing sewers flows and repair of existing sewer pipes
20. Removal and disposal of existing sewer structures and pipe as and where indicated in the Drawings
21. Temporary utilities for construction and to maintain existing service during construction
22. Temporary utility services to buildings as required to maintain service during construction
23. Quality assurance testing
24. Temporary construction and other facilities not to be permanently incorporated into the Work necessary for construction sequencing and maintenance of operations
25. Weather protection
26. Permits not otherwise paid for or provided by the Owner
27. Visits to the Project site or elsewhere by personnel or agents of the Contractor, including manufacturer's representatives, as may be required
28. On-site and other facilities acceptable to Engineer for the storage of materials, supplies and equipment to be incorporated into the Work

29. Facilities start-up services required by the Contract Documents
30. Test pits to determine existing utility locations and elevations, soils conditions, groundwater conditions, dewatering requirements and as required to complete the project
31. Pipe markings
32. Pavement markings
33. Removal of existing pavement
34. Earthwork (except ledge)
35. Preconstruction photos and videos
36. Construction administration and insurance

1.9 DESCRIPTION OF PAY ITEMS

A. The following sections describe the measurement of and payment for the work to be done under the respective items listed in the Bid Form.

B. Each unit or lump sum price stated in the Bid Form shall constitute full compensation, as herein specified, for each item of the work completed.

(1) Mobilization

A. Method of Measurement

1. Mobilization measured for payment shall be the costs of initiating the contract. Total of bid item shall not exceed 5% of the total amount of the base bid excluding the allowances.

C. Basis of Payment

1. Payment of the lump sum price for mobilization shall be full compensation for mobilization of equipment to begin construction and the submittal and acceptance of the Pre-Construction Photographs.

(2) Marjorie Street Pump Station Upgrade – Complete except as noted below

A. Method of Measurement

1. Marjorie Street Pump Station measured for payment shall be the lump sum for furnishing all labor, materials, tools, and equipment required for constructing the new pump station, except that work included for payment under other items.

B. Basis of Payment:

1. The lump sum price for the Marjorie Street Pump Station shall be full compensation for all labor, materials, and equipment necessary to complete the work as indicated on the Drawings and as specified and all its' appurtenances in its entirety, except that work included for payment under other items.

(3) 4-inch HDPE Force Main, All depths

A. Method of Measurement:

1. Force main pipe measured for payment shall be the number of linear feet installed measured along the center line of the pipe as laid, including fittings. Pipe installed into the manhole will not be measured for payment. Measurement of force main pipe shall start outside of the valve vault at the transition from ductile iron pipe to HDPE force main pipe.

B. Basis of payment:
   1. The contract unit price per linear foot for force main pipe, shall be full compensation for all labor, materials, and equipment necessary to complete this work including excavation (except Ledge Excavation and Disposal), dewatering, bedding, furnishing and installing pipe (including all fittings and appurtenances, concrete thrust blocks, making connections to new and existing manholes or pipes, backfill, aggregate base, compaction, cleaning, testing, handling existing flows (where applicable) during construction of new facilities and all else incidental thereto for which payment is not provided under other items.

(4) 8-inch Gravity PVC Sewer, All depths

A. Method of Measurement:
   1. Sewer pipe measured for payment shall be the number of linear feet installed measured along the center line of the pipe as laid including fittings. Pipes shall be measured between centers of the manholes minus half the inside diameter of each manhole. Pipe installed into the manhole will not be measured for payment.

B. Basis of Payment:
   1. The contract unit price per linear foot for sewer pipe shall be full compensation for all labor, materials, and equipment necessary to complete this work including sawcut, management, removal and disposal of pavement; excavation (except ledge excavation); dewatering; bedding; furnishing and installing pipe and fittings; making connections to new and existing manholes; installation of impervious material dams; backfill including aggregate base and subbase material; compaction; cleaning; testing; and all else incidental thereto for which payment is not provided under other items.
   2. Payment for this work on interim requisitions shall be according to the following percentages:
      a. Gravity sewer pipe acceptably set in place and backfilled - 90 percent.
      b. Gravity sewer pipe successfully tested - 10 percent.

(5) 4’ Diameter Sewer Manholes, All depths

A. Method of Measurement:
   1. Sanitary manholes accepted for payment shall be the actual vertical feet of structures installed and accepted complete in place, from the lowest invert to finish grade.

B. Basis of Payment:
   1. The contract unit price per vertical foot shall be full compensation for all labor, materials, tools and equipment necessary to complete this work including sawcut, management, removal and disposal of pavement; excavation (except ledge excavation); dewatering; bedding; furnishing and installing precast concrete sections, frames, covers, masonry materials, waterproofing; constructing inverts; backfilling including aggregate base and subbase material compaction; cleaning; testing; maintaining existing flows during construction; and all else incidental thereto for which payment is not provided under other items.

2. Payment for this work on interim requisitions shall be according to the following percentages:
   a. Sewer manhole acceptably set in place and backfilled - 90 percent.
   b. Sewer manhole successfully cleaned, successfully tested, and final adjustment of frame and cover - 10 percent.

(6) Ledge Excavation and Disposal

A. Where ledge is encountered, it shall be uncovered, but not excavated until measurements have been made by the Engineer unless in the opinion of the Engineer, satisfactory measurements can be made in some other manner.

B. Method of Measurement:
   1. The quantity of ledge to be paid for under this Item shall be number of cubic yards of ledge, measured in place before excavation, within the limits defined below, unless rock excavation beyond such limits has been authorized in writing by the Engineer, in which case, measurement shall be made to the authorized limits.
   2. Trench Ledge Excavation volume shall be measured as the actual volume of ledge removed between vertical planes which are a distance apart equal to the sum of 18 inches plus 1-1/3 times the nominal outside diameter of pipe which is to be installed in the trench (minimum of 3 feet) and extending to a depth of 12 inches below the invert grade of the pipe. Where two pipes are installed in the same trench, trench Ledge Excavation shall be measured as the actual volume of ledge removed between vertical planes which are a distance apart equal to the sum of 3 feet plus the sum of the pipes nominal outside diameter.
   3. Ledge excavation structures (including manholes) shall be measured as 18-inches outside the structure and extending to a depth of 6 inches below the base of the structure as indicated on the Drawings.
   4. Rocks or boulders greater than two cubic yard volume shall be considered as ledge excavation. Volume of rocks shall be determined from their average length, width, and depth as measured by the Engineer.

C. Basis of Payment:
   1. The contract unit price per cubic yard for ledge excavation shall be full compensation for all labor, materials, tools and equipment necessary to complete the excavation including drilling, blasting, excavating, loading and disposing the excess or unusable material outside the work limits, suitable replacement backfill, and all else incidental thereto for which payment is not provided under other items.
   2. Not all the potential ledge locations are identified on the Drawings and ledge could be encountered anywhere within the limits of work. Such ledge, if encountered, is not considered a Differing Subsurface or Physical Condition. The unit price in the bid form shall apply to all ledge encountered and removed.
   3. The unit price as stated in the Bid Schedule shall constitute full compensation for ledge excavation and disposal.

(7) Initial Trench Paving (Binder Course)

A. Method of Measurement:
   1. Initial Trench Paving (Binder Course) accepted for payment shall be the number of tons of pavement placed at the direction of the Engineer, calculated as described below, within the payment limits shown on the Drawings. Pavement outside of pavement limits indicated on the drawings will not be measured for payment.
   2. Actual widths will be used in computing area wherever the width of pavement removed and replaced is less than the limits indicated on the Drawings.
   3. The conversion factor to change volume of bituminous concrete pavement measured in place to tons will be 0.055 tons per square yard per inch of thickness.

B. Basis of Payment:
   1. Initial Trench Paving (Binder Course) shall be paid for at the Contract unit price per ton as stated in the Bid Schedule. Said unit price shall be full compensation for furnishing all materials, labor, equipment and tools necessary for the placement of pavement; for saw cutting pavements, furnishing and applying tack coats, temporary pavement repair, and pavement markings, as specified and as directed.

(8) Final Trench Paving (Surface Course)

A. Method of Measurement: Final Trench Paving (Surface Course) accepted for payment shall be the number of tons of pavement placed at the direction of the Engineer, calculated as described below, within the payment limits shown on the Drawings. Pavement outside of pavement limits indicated on the drawings will not be measured for payment.
   1. Actual widths will be used in computing area wherever the width of pavement removed and replaced is less than the limits indicated on the Drawings.
   2. The conversion factor to change volume of bituminous concrete pavement measured in place to tons will be 0.0575 tons per square yard per inch of thickness.

B. Basis of Payment:
   1. Final Trench Paving (Surface Course) shall be paid for at the Contract unit price per ton as stated in the Bid Schedule. Said unit price shall be full compensation for furnishing all materials, labor, equipment and tools necessary for the placement of pavement; for saw cutting pavements, furnishing and applying tack coats, temporary pavement repair, and pavement markings, as specified and as directed.

(9) Bituminous Concrete Driveways

A. Method of Measurement:
   1. Bituminous concrete driveways shall be measured for payment by the number of tons of driveway installed and accepted in place.

B. Basis of Payment:
   1. Bituminous concrete driveways will be paid for at the Contract unit price bid per ton as listed in the bid, complete in place and accepted, which price and payment shall be full compensation for all excavation, backfill, disposal of

surplus material, base, compaction, fine grading, bituminous concrete, driveway ramps, the bituminous tack coat, saw cutting and joint sealing the bituminous concrete, and all equipment, tools, labor and materials incidental thereto.

(10) Traffic Control Allowance

A. Method of Measurement:
   1. $10,000 Allowance as stated in the bid schedule.
B. Basis of Payment:
   1. Payment for traffic regulation and control shall constitute full compensation for all traffic regulation and control efforts and including all labor, materials, equipment, signage and supervision required to provide comprehensive and professional traffic regulation and control at all project locations, certified flaggers, coordinating and scheduling with City of Portsmouth Police Department; traffic control plan, temporary pavement markings for traffic re-routing and pedestrian safety; and all else incidental thereto for which payment is not provided under other items. Payment under this item will be made for full-time dedicated flaggers only. Part-time flaggers will not be considered adequate. The lump sum shall be paid in partial payments over the course of the project, where the percentage paid is equal to the percentage of completion of the entire Contract.
   2. This allowance does not include the cost for uniform police detail.

(11) Uniformed Police Officer Allowance

A. Method of Measurement:
   1. $10,000 Allowance as stated in the bid schedule.
B. Basis of Payment:
   1. The payment shall cover the cost charged to the Contractor by the City of Portsmouth Police Department for providing Uniformed Police Officers and/or cruisers for traffic control in addition to the required flag persons, only in areas required by the Owner. Excluded from this payment are any costs associated with traffic control, including flag persons, that shall be paid for under a separate item.
   2. Payment for this item shall be on the basis of invoices presented by the Police Department to the Contractor for the work. No mark-up will be added by the Contractor to the invoice.

(12) Utility Service Allowance

A. Method of Measurement:
   1. $40,000 Allowance as stated in the bid schedule.
B. Basis of Payment:
   1. Utility service shall be paid for as an allowance stated in the Bid Schedule. Said allowance shall be full compensation for cost charged to the Contractor by any of the following utility companies: Eversource, Until, Comcast/Xfinity, and Consolidated Communications. Costs covered by this allowance include but are not limited to extending the gas main approximately 200-feet and installing one new service to the generator site; holding of communication wires or relocation

of communication lines for the construction of the pump station, connections to the new utility transformer. The new utility transformer will be installed by Eversource at no charge to the General Contractor or Owner.

2. The allowance shall be paid on the basis of invoices presented by the utility companies to the Contractor for the work completed. No mark-up will be added by the Contractor to the utility company invoices.

(13) Programming Integration Services Allowance

A. Method of Measurement:
   1. $13,635 Allowance as stated in the bid schedule.
B. Basis of Payment:
   1. Programming integration services shall be paid for as an allowance stated in the Bid Schedule. Programming Integrator shall provide the programming as indicated on the Drawings, as specified in Section 13441, and as referenced. All costs associated with field conduit and wiring; field testing shall be included in Item 2.
   2. Adjustment to the final cost for this Item, if necessary, will be made in accordance with the General Conditions. Owner will assist Contractor in establishing any adjustments to this item.

(14) Removal and Disposal of Asbestos Cement Pipe

A. Method of Measurement:
   1. Removal and disposal of asbestos cement pipe accepted for payment shall be the actual number of linear feet of asbestos cement pipe (all diameters) removed and disposed of in accordance with local, State and Federal Regulations, as measured along the center line of the pipe.
B. Basis of Payment:
   1. The Contract unit price per linear foot for removal and disposal of asbestos cement pipe shall be full compensation for all labor, subcontractors, materials, tools and equipment necessary to complete this work including sawcut, management, removal and disposal of pavement; excavation (except ledge excavation); segregating, handling, staging, testing, and storage of all asbestos pipe and soil suspected of containing asbestos as well as the costs associated with all controls necessary to maintain compliance with regulatory requirements relative to handling asbestos materials; submittal and approval of all required and specified plans; health and safety equipment; all costs related to transporting and disposal asbestos material from the staging area to an approved disposal facility shall be included for payment in this item; air monitoring; controlling the spread of airborne contaminants; all notifications, fees, permits, and taxes; coordination with regulatory agencies and Owner; all other requirements specified in other sections of the Contract Documents; and all else incidental thereto for which payment is not provided under other items.

(15) Unsuitable Earth Excavation below Grade and Replacement Backfill

A. Method of Measurement: Earth excavation below grade (below the bottom of the bedding layer by order of the Engineer) and replacement backfill below grade accepted for payment shall be the actual number of cubic yards installed and accepted

complete in place.

B. Basis of Payment:

1. The Contract unit price per cubic yard for earth below grade and replacement backfill below grade furnished and installed shall be full compensation for labor, materials, tools and equipment necessary to complete this work including; excavation and disposal of unsuitable materials including muck, crib work, trees, stumps and all other buried refuse; furnish, install and compact replacement suitable fill; dewatering; and all else incidental thereto for which payment is not provided under other items.
2. The depth of unsuitable material in pipe trenches to be paid shall be measured from 2 feet below the invert of the pipe to the depth of excavation. The width of unsuitable material in pipe trenches to be paid shall be as detailed in the Trench Detail included with the Contract Drawings.
3. The depth of unsuitable material in structure excavations to be paid shall be measured from 12 inches below the bottom of the structure slab to the depth of excavation. The width of unsuitable material in structure excavations shall be based on a 1:1 slope from the edge of the bottom of the structure to the top of the acceptable material.

END OF SECTION

SECTION 01200

PROJECT MEETINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: To enable orderly review during progress of the work, and to provide for systematic discussion of problems, the Engineer will conduct project meetings throughout the construction period.

B. Related work described elsewhere: The Contractor's relations with their subcontractors and materials suppliers and discussions relative thereto, are the Contractor's responsibility and are not part of project meetings content.

1.2 QUALITY ASSURANCE

A. Persons designated by the Contractor to attend and participate in the project meetings shall have all required authority to commit the Contractor to solutions agreed upon in the project meetings.

1.3 SUBMITTALS

A. Agenda items: To the maximum extent practicable, advise the Engineer at least 24 hours in advance of project meetings regarding all items to be added to the agenda.

B. Minutes: The Engineer will compile minutes of each project meeting and will furnish a copy to the Contractor. The Contractor may make and distribute such other copies as they wish.

PART 2 - PRODUCTS

(No products are required in this Section.)

PART 3 - EXECUTION

3.1 MEETING SCHEDULE

A. Except as noted below for Preconstruction Meeting, project meetings will be held monthly. Coordinate as necessary to establish mutually acceptable schedule for meetings.

3.2 MEETING LOCATION

A. Meetings will be held at the job site in the Engineers' field office, unless the Owner and/or Engineer determine that virtual meetings are applicable and appropriate for any reason (e.g., COVID, Safety and Health Plan, etc.).

1. If meetings are required by Owner/Engineer to be held virtually, Engineer will host the meetings via Microsoft Teams. All required meeting attendees are responsible for providing hardware necessary to view, share, be heard and hear content of the meeting.

3.3 PRECONSTRUCTION MEETING

A. Preconstruction meeting will be scheduled within twenty days after the Effective Date of the Agreement, but before the Contractor starts work at the site. Provide attendance by authorized representatives of the Contractor and all major subcontractors. The Engineer will advise other interested parties and request their attendance.

B. Minimum agenda: Distribute data on, and discuss:
   1. Identification of key project personnel for Owner, Engineer, Contractor, funding/regulatory Agencies.
   2. Responsibilities of Owner, Engineer, Resident Project Representative, Contractor.
   3. Channels and procedures for communications.
   4. Construction schedule, including sequence of critical work.
   5. Easements, permits.
   6. Contract Documents, including distribution of required copies of original documents and revisions.
   7. Processing of Shop Drawings and other data submitted to the Engineer for review.
   8. Processing of field decisions and Change Orders.
   9. Rules and regulations governing performance of the Work, including funding/regulatory Agency requirements.
   10. Procedures for safety and first aid, security, quality control, housekeeping, and other related matters.

3.4 PROJECT MEETINGS

A. Attendance: To the maximum extent practicable, assign the same person or persons to represent the Contractor at project meetings throughout progress of the Work. The Superintendent shall attend. Subcontractors, materials suppliers, and others may be invited to attend those project meetings in which their aspects of the Work are involved.

B. Minimum agenda:
   1. Review, revise as necessary, and approved minutes of previous meeting.
   2. Review progress of the Work since last meeting, including status of submittals for approval.
   3. Review schedule of work to be accomplished prior to next meeting.
   4. Discuss monthly partial payment request.
   5. Review status of change order requests and Work Directive Changes.
   6. Identify problems which impede planned progress.
   7. Develop corrective measures and procedures to regain planned schedule.
   8. Complete other current business.

END OF SECTION

SECTION 01310

CONSTRUCTION SCHEDULES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Within ten (10) days after the effective date of the Agreement between Owner and Contractor submit to the Engineer an estimated progress schedule as specified herein.

B. Form of Schedules:
   1. Narrative: Completely describe the construction methods to be employed.
   2. Network Analysis System:
      a. Provide a separate horizontal schedule line for each trade or operation and show concurrent and preceding activities.
      b. Present in chronological order the beginning of each trade or operation showing duration and float time.
      c. Scale: Identify key dates and allow space for updating and revision.
   3. Mathematical Analysis:
      a. A mathematical analysis shall accompany the network diagram. A computer printout will be acceptable.
      b. Information shall be included on activity numbers, duration, early start, late start, etc. and float times.

C. Content of Schedules:
   1. Provide complete sequence of construction by activity:
      a. Shop Drawings, Project Data and Samples:
         i. Submittal dates.
         ii. Dates reviewed copies will be required.
      b. Decision dates for:
         i. Products specified by allowances.
         ii. Selection of finishes.
      c. Estimated product procurement and delivery dates.
      d. Dates for beginning and completion of each element of construction.
   2. Identify work of separate phases and logically grouped activities.
   3. Show the projected percentage of completion for each item of work as of the first day of each month.
   4. Provide separate sub-schedules, if requested by the Engineer, showing submittals, review times, procurement schedules, and delivery dates.
   5. Schedule sheets shall be printed in color on 24”x36” paper, unless a smaller size paper is allowed by the Engineer.

D. Updating:
   1. Show all work activities including those already complete.
   2. Show all changes occurring since previous submission.
   3. Indicate progress of each activity, show completion dates.

4. Include:
   a. Major changes in scope.
   b. Activities modified since previous updating.
   c. Revised projections due to changes.
   d. Other identifiable changes.
5. Provide narrative report, including:
   a. Discussion of problem areas, including current and anticipated delay factors.
   b. Corrective action taken or proposed.
   c. Description of revisions that may affect schedules.
   d. Description of activities to be performed in the next 6-week period.
   e. Updated list of key shop drawings, project data and samples to be submitted in the next 6-week period.

1.2 SUBMITTALS

A. Submit updated schedules with each progress payment request.
B. Submit 4 copies of initial and updated schedules to the Engineer.

END OF SECTION

SECTION 01320

SAFETY AND HEALTH PLAN

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:

1. The Contractor shall be solely responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the work, as outlined herein and in the General and Special Conditions of the Contract Documents. Within 10 days after the effective date of the Agreement between Owner and Contractor, submit to the Engineer a Safety and Health Plan as specified herein. Refer to submittals section below.
2. Contractor shall comply with all applicable Laws and Regulations related to the safety of persons or property, or for the protection of persons or property from damage, injury, illness, or loss; and shall erect and maintain all necessary safeguards for such safety and protection.
3. Contractor shall designate a qualified and experienced safety representative (OSHA defined "Competent Person") at the site whose duties and responsibilities shall be the prevention of accidents and maintaining and supervising of safety precautions and programs, including a "Job Hazards Analysis".
4. The Contractor shall be solely responsible to provide all labor, equipment, and utilities sufficient to ensure no construction noise, particulates, or odors, are allowed to accumulate to levels which adversely affect health or work in, or near the construction area.

B. Content of Safety and Health Plan:

1. Prepare complete safety and health plan in accordance with the requirements of CFR Title 29 Part 1926 - Safety and Health Regulations for Construction.
    a. Provide documentation that Contractor's hazardous communication program is up to date.
    b. Provide documentation that Contractor's safety training is up to date.
    c. Prepare a project specific Safety and Health Plan addressing construction safety issues, including but not limited to excavations, fall protection and egress, as well as provisions for construction in hazardous environmental conditions at the wastewater treatment facility. The hazardous environmental conditions at the wastewater treatment facility include, but are not limited to, confined space entry, electrically classified spaces, chemical storage and handling areas, biological hazards, to name a few.
2. Safety provisions for confined space entry shall follow the requirements of CFR Title 29 Part 1926, Subpart AA – Confined Spaces in Construction and will be incorporated into the Safety and Health Plan.

C. Updating:

1. Contractor shall be responsible for updating the Safety and Health Plan as appropriate throughout the course of the construction period.

1.2 SUBMITTALS

A. Submit the Contractor's site-specific Safety and Health Plan to the Engineer, in accordance with Section 01340. Submit hardcopy submittals, if required.

B. Submit updated Safety and Health Plans as necessary during the course of the project.

C. The Safety and Health Plan is provided "for information only" to inform the Owner, Engineer and Resident Project Representative of the project specific safety program requirements; however, if the Safety and Health Plan incomplete (e.g., missing elements relevant to the project work), inadequate (e.g., outdated qualifications) or not project-specific, it will be returned "revise and resubmit". Delays related to an incomplete Safety and Health Plan are the responsibility of the Contractor.

D. The Contractor will overview the plan with the Owner (and staff), Engineer (and Resident Project Representative) prior to work beginning at the project site, and subsequently when/if the safety plan is updated.

E. Contractor's most current Safety and Health Plan shall be available at the construction site throughout the construction project.

1.3 ON-SITE COORDINATION MEETINGS

A. Contractor shall review key aspects of Safety and Health Plan at the Pre-Construction Meeting, and subsequent on-site safety informational meeting.

B. Contractor shall report to Engineer and Owner at each progress meeting concerning compliance with the Safety and Health Plan for the most recent construction period and new considerations and requirements for the upcoming period.

C. Contractor shall hold weekly on-site coordination meetings with Resident Project Representative and Owner to ensure that Owner's staff is aware of key Safety and Health Plan requirements of the current phase of construction.

1.4 OWNER'S CONFINED SPACE ENTRY PROGRAM INFORMATION

A. A copy of the Owner's Confined Space Entry Program is available for viewing at the facility and is not included herein.

END OF SECTION

SECTION 01340

SUBMITTALS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:
   1. Submit all shop drawings, operations and maintenance manuals, Manufacturers' certificates, project data, and samples required by the Specifications.

B. Related Work Specified Elsewhere:
   1. Construction Schedules: Section 01310
   2. Project Record Documents: Section 01720
   3. General Conditions: NHDES Division 0

C. Submittals: This project shall utilize:
   1. Submittals – Electronic via Email/FTP with Hard Copy for Record
      a. The Contractor shall submit to the Engineer an electronic submittal of shop drawings and O&M Manuals in portable document format (PDF) transmitted via email or file transfer protocol (FTP). The Engineer shall return an electronic PDF of the submittal review comments to the Contractor for distribution to subcontractors, suppliers and manufacturers. The electronic submittals shall serve as the electronic record of the project.
      b. In addition, completed shop drawings and completed operations and maintenance (O&M) manuals shall be provided in hard copy (paper) format, for the record, in accordance with the following requirements.
         i. Shop drawings and O&M manuals shall be considered "completed" once an action code of "0" or "1" has been attained, as specified below, unless otherwise directed by the Engineer.
         ii. Once completed, the Contractor shall provide three hard copy sets (for Owner, Engineer and Resident Project Representative, respectively).
         iii. Hard copy submittals shall be updated on a monthly basis, for those submittals completed during the preceding month.

1.2 SHOP DRAWINGS

A. Shop Drawings are required for each and every element of the work.

B. Shop Drawings are generally defined as all fabrication and erection drawings, diagrams, brochures, schedules, bills of material, manufacturers data, spare parts lists, and other data prepared by the Contractor, their subcontractors, suppliers, or manufacturers which illustrate the manufacturer, fabrication, construction, and installation of the work, or a portion thereof.

C. The Contractor shall provide a completed Contractor Submittal Certification Form (copy provided for Contractor's use at the end of this Specification Section) which shall be attached to every copy of every shop drawing and signed by the Contractor and Manufacturer (where applicable). Shop Drawings shall show the principal dimensions, weight, structural and operating features, space required, clearances, type and/or brand of finish or shop coat, grease fittings, etc., depending on the subject of the drawing. When it is customary to do so, when the dimensions are of particular importance, or when so specified, the drawings shall be certified by the manufacturer

or fabricator as correct for the work.

1. Each shop drawing submittal shall include a complete copy of the relevant specification section markup up to reflect “compliance” or “deviation” on an item-by-item basis.

D. Shop Drawings shall be submitted as a complete package by specification section, unless otherwise reviewed and approved by the Engineer. It is the intent that all information, materials and samples associated with each specification section be included as a single submittal for the Engineer's review. Any deviation from this requirement, shall be requested in writing with an anticipated shop drawing breakdown/schedule prior to any associated submittal. An exception to this requirement are shop drawings for reinforcing steel, miscellaneous metals and structural steel, which shall be submitted separately for each structure unless otherwise permitted by the Engineer.

E. The Contractor shall be responsible for the prompt and timely submittal of all shop and working drawings so that there shall be no delay to the work due to the absence of such drawings.

F. No material or equipment shall be purchased or fabricated especially for the Contract until the required shop and working drawings have been submitted as hereinabove provided and reviewed for conformance to the Contract requirements. All such materials and equipment and the work involved in their installation or incorporation into the Work shall then be as shown in and represented by said drawings.

G. Until the necessary review has been made, the Contractor shall not proceed with any portion of the work (such as the construction of foundations), the design or details of which are dependent upon the design or details of work, materials, equipment or other features for which review is required.

H. All shop and working drawings shall be submitted to the Engineer by and/or through the Contractor, who shall be responsible for obtaining shop and working drawings from their subcontractors and returning reviewed drawings to them. Shop drawings shall be formatted to standard paper sizes to enable the Owner to maintain a permanent record of the submissions. Approved standard sizes shall be: (a) 24 inches by 36 inches; (b) 11 inches by 17 inches, and (c) 11 inches by 8-1/2 inches. Provision shall be made in preparing the shop drawings to provide a binding margin on the left hand side of the sheet. Shop drawings submitted other than as specified herein may be returned for resubmittal without being reviewed.

I. Only drawings which have been checked and corrected by the fabricator should be submitted to the Contractor by their subcontractors and vendors. Prior to submitting drawings to the Engineer, the Contractor shall check thoroughly all such drawings to confirm that the subject matter thereof conforms to the Drawings and Specifications in all respects. All drawings which are correct shall be marked with the date, checker's name, and indication of the Contractor's approval, and then shall be submitted to the Engineer.

J. If a shop drawing shows any deviation from the Contract requirements, the Contractor shall make specific mention of the deviations in the transmittal. Shop Drawings that contain significant deviations that are not brought to the attention of the Engineer may be subject to rejection.

K. Should the Contractor submit equipment that requires modifications to the structures, piping, electrical conduit, wires and appurtenances, layout, etc., detailed on the Drawings, Contractor shall also submit details of the proposed modifications. If such equipment and modifications are accepted, the Contractor, at no additional cost to the Owner, shall do all work necessary to make such modifications.

L. A maximum of two submissions of each Shop Drawing will be reviewed, checked, and commented upon without charge to the Contractor. Any additional submissions which are ordered by the Engineer to fulfill the stipulations of the Drawings and Specifications, and which are required by virtue of the Contractor's neglect or failure to comply with the requirements of the Drawings and Specifications, or to make those modifications and/or corrections ordered by the Engineer in the review of the first two submissions of each Shop Drawing, will be reviewed and checked as deemed necessary by the Engineer, and the cost of such review and checking, as determined by the Owner, and based upon Engineer's documentation of time and rates established for additional services in the Owner-Engineer Agreement for this Project, may be deducted from the Contractor to make all modifications and/or corrections as may be required by the Engineer in an accurate, complete, and timely fashion. Resubmittals for the sole purpose of providing written responses to review comments will not be considered a resubmittal counting towards the two-submission limit.

M. Shop Drawings that include drawings or other material that is illegible or too small may be returned without review.

1.3 SAMPLES

A. The Contractor shall submit samples when requested by the Engineer to establish conformance with the specifications, and as necessary to define color selections available. Submittals of “samples” shall be documented through the electronic submittal process by including a photograph of the item(s) and indicating the date the sample was mailed and/or delivered.

1.4 OPERATION AND MAINTENANCE MANUALS

A. Operation and Maintenance (O&M) Manuals are required for certain elements of the project, as specified herein.

B. The Contractor shall provide a completed Operation and Maintenance Manual Certification Form (copy provided for Contractor's use at the end of this Specification Section) which shall be attached to every copy of every Manual and signed by the Contractor and Manufacturer.

C. Each hard copy of an O&M Manual shall be provided in a stand-alone binder or shall be suitable for insertion into a 3-ring binder. Include the General Contractor's and Manufacturer's representative's contact information on the front cover. O&M manuals must be appropriate for the project and customized for the project. If a Manufacturer's standard O&M manual is included in the submittal, all non-applicable content must be removed or crossed out.

D. O&M Manuals shall contain the following operational information:

1. Safety Precautions: List personnel hazards, equipment or product safety precautions for all operating conditions.
2. Operator Prestart: Include all procedures required to set up and prepare each system, equipment or component for use.

3. Startup Procedures: Provide a narrative description for all startup operating procedures, include all control sequences.
4. Shutdown Procedures: Provide a narrative description for all shutdown operating procedures, include all control sequences.
5. Post-Shutdown Procedures: Provide a narrative description for all post-shutdown operating procedures, include all control sequences.
6. Normal Operating Procedures: Provide a narrative description of normal operating procedures. Include control diagrams with data to explain operation and control of systems and specific equipment.
7. Emergency Operations: Include emergency procedures for equipment malfunctions to permit a short period of continued operation or to shut down the equipment to prevent further damage to systems and equipment. Include emergency shutdown instructions for fire, explosion, spills, or other foreseeable contingencies. Provide guidance on emergency operations of all utility systems including valve locations and portions of systems controlled.
8. Operator Service Requirements: Include instructions for services to be performed by the operator such as lubrication, adjustment, inspection, alignment, spare parts installation and gage reading or recording.
9. Environmental Conditions: Include a list of environmental conditions (temperature, humidity, and other relevant data) which are best suited for each product or piece of equipment and describe conditions under which the equipment should not be allowed to run.

E. O&M Manuals shall contain the following maintenance information:
1. Lubrication Data: Include a table showing recommended lubricants for specific temperature ranges and applications. Also, include charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, capacities and a lubrication schedule showing service interval frequency
2. Preventative Maintenance Plan: Include the manufacturer's schedule for routine preventive maintenance, inspections, tests and adjustments required to ensure proper and economical operation as well as to ensure minimization of corrective maintenance and repair. Provide the manufacturer's projection of preventive maintenance workhours on a daily, weekly, monthly, and annual basis including craft requirements by type of craft. For periodic calibrations, provide the manufacturer's specified frequency and procedures for each separate operation.
3. Troubleshooting Guides: Include recommendations on procedures and instructions for correcting problems and making repairs. Provide step-by-step procedures to promptly isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or require replacement.
4. Wiring and Control Diagrams: Provide Wiring diagrams and control diagrams. All diagrams shall be point-to-point drawings of wiring and control circuits including factory-field interfaces. Provide a complete and accurate depiction of the actual job specific wiring and control work. On diagrams, number

electrical and electronic wiring and pneumatic control tubing and the terminals for each type, identically to the actual installation numbering.

5. Maintenance and Repair Procedures: Include instructions and list the tools required to restore products and/or equipment to proper conditions or operating standards.
6. Removal and Replacement Instructions: Include step-by-step procedures, list required tools/supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings and adjustments required. Instructions shall include a combination of text and illustrations.
7. Spare Parts and Supply Lists: Include lists of spare parts and supplies required for maintenance and repair to ensure continued service or operation without unreasonable delays. Special consideration shall be required for facilities at remote locations. List spare parts and supplies that have a long lead times to obtain.
8. Corrective Maintenance Work Hours: Include the manufacturer's projection of corrective maintenance workhours including craft requirements by type of craft. Corrective maintenance that requires participation of the equipment manufacturer shall be identified and tabulated separately.

F. O&M Manuals shall contain the following additional information:

1. Parts Identification: Provide identification and coverage for all parts of each component, assembly, subassembly, and accessory of the end items subject to replacement. Include special hardware requirements, such as requirements to use high-strength bolts and nuts. Identify parts by make, model, serial number, and source of supply to allow reordering without further identification. Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items.
    a. When illustrations omit a part number and description, both the illustration and a separate listing shall show the index, reference, or key number which shall cross-reference the illustrated part to the listed part. Parts shown in the listings shall be grouped by components, assemblies, and subassemblies. Parts data may cover more than one model or series of equipment, components, assemblies, subassemblies, attachments, or accessories, such as a master parts catalog, in accordance with the manufacturer's standard commercial practice.
2. Warranty Information: List and explain the various warranties and include the servicing and technical precautions prescribed by the manufacturers or contract documents to keep warranties in force. Include warranty information for all primary components included in product systems.
3. Personnel Training Requirements: Provide information available from the manufacturers to use in training designated personnel to operate and maintain the equipment and systems properly.
4. Testing and Special Tools: Include information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components.

5. Contractor Information: Provide a list that includes the name, address, and telephone number of the General Contractor and each subcontractor installing the respective product or equipment. Include local representatives and service organizations most convenient to the project site. Provide the name, address, and telephone number of the product or equipment manufacturers.
6. Written confirmation from the manufacturer that the Contractor has coordinated the equipment One Year Service Call in accordance with specification Section 01800, par. 1.1, A, 2.

1.5 MANUFACTURER'S CERTIFICATES

A. Prior to accepting the installation, the Contractor shall submit manufacturer's certificates for each item specified.

B. Such manufacturer's certificates shall state that the equipment has been installed under either the continuous or periodic supervision of the manufacturer's authorized representative, that it has been adjusted and initially operated in the presence of the manufacturer's authorized representative, and that it is operating in accordance with the specified requirements, to the manufacturer's satisfaction. All costs for meeting this requirement shall be included in the Contractor's bid price.

1.6 SUBMISSION REQUIREMENTS

A. Accompany submittals with a transmittal cover sheet, containing:
   1. Date.
   2. Project title and number.
   3. Contractor's name and address.
   4. The sequential shop drawing number for each shop drawing, project data and sample submitted shall be:
      a. Specification Section number followed by a dash and then a sequential number beginning with 01 (e.g., 16000-01).
      b. Under limited situations when additional different pieces of equipment are submitted under the same specification section, those submittals shall be numbered sequentially (e.g. 05500-01, 05500-02, 05500-03, etc.).
      c. Resubmittals shall include an alphabetic suffix after the corresponding sequential number (e.g., 16000-01A).
      d. O&M submittals shall be numbered with the Specification Section number followed by a dash, the letters “OM”, another dash, and then a sequential number beginning with 01 (e.g. 16000-OM-01). Resubmittals of O&Ms shall include an alphabetic suffix after the corresponding sequential number (e.g. 16000-OM-01A).
   5. Notification of deviations from Contract Documents.
   6. Other pertinent data.

B. A completed Contractor Submittal Certification Form shall be attached to each hardcopy and electronic PDF of each shop drawing and must include:
   1. Project name
   2. Specification Section and sequential number with alphabet suffix for resubmittal
   3. Description
   4. Identification of deviations from Contract Documents.

5. Contractor's stamp, initialed or signed, certifying review of the submittal, verification of field measurements and compliance with Contract Documents.
6. Where specified or when requested by the Engineer, manufacturer's certification that equipment, accessories and shop painting meet or exceed the Specification requirements.
7. Where specified, manufacturer's guarantee.

C. Additional Requirements for Electronic Submittals:
1. Each individual shop drawing or O&M submittal shall be contained in one PDF.
2. The first page of the PDF shall be the Contractor Submittal Certification Form as described above.
3. The electronic PDF shall be **exactly** as submitted in the hardcopy.
4. The electronic PDF shall include an electronic table of contents that is bookmarked for each section of the submittal.
5. The electronic PDF shall be configured such that is fully searchable.
6. PDF versions of 24x36 drawings shall be converted to 24 x 36 PDFs so as not to lose the clarity of the original drawing.
7. Electronic PDF submittals that are not submitted in accordance with the requirements stated above will not be reviewed by the Engineer.
8. Electronic submittals shall be transmitted via the protocol established in Part 1 above.

1.7 RESUBMISSION REQUIREMENTS

A. Revise initial submittals as required and resubmit as specified for initial submittal.
B. Indicate on submittals any changes which have been made other than those required by Engineer. All renumbering of shop drawings, relabeling of individual pieces or assemblies or relocating of pieces or assemblies to other Drawings within the submittal shall be clearly brought to the attention of the Engineer. If relabeling of individual pieces or assemblies has taken place, the labels from the previous submittal shall be indicated to assist in comparing the original and resubmitted shop drawing.
C. All resubmittals shall include a summary of the previous submittal review comments with the vendors' written response as to how the previous comments were addressed.

1.8 ENGINEER'S REVIEW

A. The review of shop and working drawings hereunder will be general only, and nothing contained in this specification shall relieve, diminish or alter in any respect the responsibilities of the Contractor under the Contract Documents and in particular, the specific responsibility of the Contractor for details of design and dimensions necessary for proper fitting and construction of the work as required by the Contract and for achieving the result and performance specified thereunder.
B. The Engineer's review comments will be summarized on a Submittal Review Form, which includes an action code. A description of each action code is provided below.
1. No Exceptions Taken (Status 0 on shop drawing log). The shop drawing complies with the Contract Document requirements. No changes or further information are required. Where appropriate, the submittal review form will be used to alert the Contractor, Owner and Field personnel of remaining items within that specification section that still needs to be submitted.

2. Make Corrections Indicated (Status 1 on shop drawing log). The shop drawing complies with the Contract Document requirements except for minor changes, as indicated. Engineer requires that all comments will be addressed by the Contractor, unless otherwise notified in writing prior to execution of the relevant work.
3. Conditional to Remarks (Status 2 on shop drawing log). The shop drawing potentially complies with the Contract Document requirements, contingent upon satisfactory resolution of review comments. Remarks will explicitly list what information needs to be resubmitted. Resubmittal from the Contractor should include a cover letter or summary which indicates how each review comment has been addressed. **This action code will not be used, or will be sparingly used, for electronic submittals.**
4. Revise and Resubmit (Status 3 on shop drawing log). The shop drawing does not comply with the Contract Document requirement as submitted, but may with changes indicated and/or submission of additional information. The entire package must be resubmitted with the necessary information and a cover letter which indicates how each review comment has been addressed and where to find the information in the resubmittal.
5. Rejected (Status 4 on shop drawing log). The shop drawing does not comply with the Contract Document requirements, for the reasons indicated in the remarks, and is unacceptable.
6. In Review (Status 5 on shop drawing log). The shop drawing is currently under review.
7. For Information Only (Status 6 on shop drawing log). The shop drawing review was for information only.

CONTRACTOR SUBMITTAL CERTIFICATION FORM

PROJECT: _____ CONTRACTOR'S PROJ. NO: _____

CONTRACTOR: _____ ENGINEER'S PROJ. NO: _____

ENGINEER: _____

SHOP DRAWING NUMBER: _____ - _____

SPECIFICATION SECTION OR DRAWING NO: | SEQUENTIAL NUMBER (& ALPHA SUFFIX FOR RESUBMITTAL)

DESCRIPTION: _____

MANUFACTURER: _____

The above referenced submittal has been reviewed by the undersigned and I/we certify that the material and/or equipment meets or exceeds the project specification requirements with

☐ NO DEVIATIONS

or

☐ A COMPLETE LIST OF DEVIATIONS AS FOLLOWS[a]:

_____
_____
_____
_____

By: _____ By: _____

Contractor[b]

Manufacturer[c]

Date: _____ Date: _____

a Any deviations not brought to the attention of the Engineer for review and concurrence shall be the responsibility of the Contractor to correct, if so directed.
b Required on all submittals
c When required by specifications Page ___ of ___

General Contractor's Stamp

OPERATIONS AND MAINTENANCE MANUAL CERTIFICATION FORM

PROJECT: _____ CONTRACTOR'S PROJ. NO: _____

CONTRACTOR: _____ ENGINEER'S PROJ. NO: _____

ENGINEER: _____

O&M NUMBER: _____ SPECIFICATION SECTION OR DRAWING NO: - OM- _____ SEQUENTIAL NUMBER (& ALPHA SUFFIX FOR RESUBMITTAL)

DESCRIPTION: _____

MANUFACTURER: _____

The above referenced operations and maintenance manual has been reviewed by the undersigned and I/we certify that the manual is customized as needed for this project, is suitable for mounting in a 3-ring binder, and contains the following items:

- ☐ Table of Contents
- ☐ Contractor and Manufacturer Contact Information
- ☐ Preventative Maintenance Schedule and Summary
- ☐ Removal and Replacement Instructions
- ☐ Lubrication Schedule
- ☐ Troubleshooting Information
- ☐ Warranty Information
- ☐ Rebuild Information for All Components
- ☐ Startup, Operation and Shutdown Procedures
- ☐ Normal and Emergency Operations
- ☐ Safety Procedures and Precautions
- ☐ Shop Drawings corrected to As-Built Conditions
- ☐ Personnel Training Requirements
- ☐ Project-Related Design Data
- ☐ Serial Numbers
- ☐ Maintenance and Repair Procedures
- ☐ Wiring and Control Diagrams
- ☐ Equipment Drawings & Schematics
- ☐ Equipment Performance Curves
- ☐ Parts and Service Contact Information
- ☐ Manufacturer's Contact Information
- ☐ Emergency Operations Plan
- ☐ List of All Component Part Numbers
- ☐ List of Spare Parts Supplied
- ☐ Testing Equipment & Special Tools
- ☐ Other System Specific Information

By: _____ By: _____

Contractor[a] Manufacturer[b]

Date: _____ Date: _____

[a] Contact information shall include name, address and telephone number.
[b] Required on all Operation and Maintenance Manuals.
[c] When required by Specifications.

General Contractor's Stamp

PROCESS EQUIPMENT MANUFACTURER SUBMITTAL CERTIFICATION
(Divisions 11 and 14)

Owner:_____ Date: _____

Project:

Contractor:

Equipment Manufacturer:

Equipment:

As an authorized representative of the equipment manufacturer, the undersigned certifies that the equipment listed above conforms to the requirements of Section 11000, Part 1.3.K. The undersigned authorized representative of the manufacturer further certifies that the equipment manufacturer or supplier has: reviewed the Construction Documents, the intended installation by the Contractor, and the intended functional and operational conditions; determined all conditions to be acceptable; and found no conditions which would cause the warranty to be void; or the equipment to function improperly, or not meet the performance requirements.

(Authorized Representative of the Manufacturer) (Date)

END OF SECTION

SECTION 01370

SCHEDULE OF VALUES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:

1. Provide a detailed breakdown of the Lump Sum items showing values allocated to each of the various parts of the Work, as specified herein and in other provisions of the Contract Documents. The breakdown shall divide the projects into its appropriate component parts together with a quantity and a unit price for each part such that the sum of the products of quantities and unit prices will equal the contract price for the item(s). Coordinate with the Engineer regarding the level of detailed warranted for the project.

B. Related Work Specified Elsewhere:

1. NHDES Division 0 – General Conditions
2. NHDES Division 0 – Supplemental Conditions
3. NHDES Division 0 – Contractor’s Application for Payment
4. Section 01340 – Submittals

1.2 QUALITY ASSURANCE

A. Use required means to assure arithmetical accuracy of the sums described.

B. When so required by the Engineer, provide copies of the subcontracts or other data acceptable to the Engineer substantiating the sums described.

1.3 SUBMITTALS

A. Prior to first application for payment, submit a proposed schedule of values to the Engineer.

1. Secure the Engineer's approval of the schedule of values prior to submitting first application for payment.

END OF SECTION

SECTION 01380

CONSTRUCTION PHOTOGRAPHS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:

1. Pre-Construction Record: Contractor shall take digital photographs and video to obtain a visual record of the project area prior to beginning any work at the project site.
2. Notify Engineer at least three (3) working days prior to photographing or videoing the project area so Engineer may, at their option, observe.

1.2 QUALITY

A. Pre-Construction Record: Quality shall be such that the condition of existing pavement, curbing, driveway entrances, sidewalks, walls, doors, equipment, piping, etc. can be readily determined.

1.3 SUBMITTAL OF PRINTS

A. Pre-Construction Record:

1. Submit pre-construction photographs/videos in accordance with Section 01340 prior to initiating any work on-site.

B. The quality of the photos and video are subject to approval by the Engineer.

C. Photographs and videos taken for the project and submitted are released to the Owner and Engineer for reproduction and use for records retention, governmental and commercial purposes.

END OF SECTION

SECTION 01400

QUALITY CONTROL

PART 1 - GENERAL

1.1 REQUIREMENTS INCLUDED

A. General Quality Control.
B. Workmanship.
C. Manufacturer's Instructions.
D. Manufacturer's Certificates.
E. Manufacturer's Field Services.
F. Testing Laboratory Services.

1.2 RELATED REQUIREMENTS

A. NHDES Division 0 - General Conditions: Inspection and testing required by governing authorities.
B. Section 01340 - Submittals: Submittal of Manufacturer's Instructions
C. Section 02200 - Earthwork
D. Section 02513 – Bituminous Concrete Paving
E. Section 03300 - Cast-in-Place Concrete

1.3 QUALITY CONTROL

A. Maintain quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.

1.4 WORKMANSHIP

A. Comply with industry standards except when more restrictive tolerances or specified requirements indicate more rigid standards or more precise workmanship.
B. Perform work by persons qualified to produce workmanship of specified quality.
C. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, and racking.

1.5 MANUFACTURERS' INSTRUCTIONS

A. Comply with instructions in full detail, including each step in sequence. Should instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

1.6 MANUFACTURERS' CERTIFICATES

A. When required by individual Specifications Section, submit manufacturer's certificate that products meet or exceed specified requirements.

1.7 MANUFACTURERS' FIELD SERVICES

A. When specified in respective Specification Sections, require supplier and/or manufacturer to provide qualified personnel to observe field conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust and balance of equipment as applicable, and to make appropriate recommendations.

B. Representative shall submit written report to Engineer listing observations and recommendations.

1.8 TESTING LABORATORY SERVICES

A. Owner will employ and pay for services of an Independent Testing Laboratory to perform inspections, tests, and other services wherever an Independent Testing Laboratory is required by individual specification sections listed in paragraph 1.2 above, unless otherwise indicated.

B. Services will be performed in accordance with requirements of governing authorities and with specified standards.

C. Reports will present observations and test results and indicate compliance or non-compliance with specified standards and with Contract Documents. Independent Testing Laboratory will submit one copy of each report directly to each of the following: Engineer, Resident Project Representative, Contractor. Reports will be submitted within 5 days of obtaining test results. If test results indicate deficiencies, Independent Testing Laboratory shall telephone or email results to Engineer, Resident Project Representative and Contractor within 24 hours.

D. Contractor shall cooperate with Independent Testing Laboratory personnel; furnish tools, samples of materials, design mix, equipment, storage and assistance as requested.

E. Contractor shall coordinate all testing work and shall notify Engineer and Independent Testing Laboratory at least 24 hours prior to performing work requiring testing services. If scheduled tests or sampling cannot be performed because the work is not ready as scheduled, testing costs associated with the delay will be determined by Engineer and invoiced by Owner to Contractor. If unpaid after 60 days, the invoice amount will be deducted from the Contract Price. If adequate notice is not provided, Contractor shall suspend work on that portion of the Project until testing can be performed. Such suspension will not be grounds for a claim against the Owner for delay, nor will it be an acceptable basis for an extension of time.

F. Payment for Independent Testing Laboratory services shall be as follows:

1. General: Where testing is the Owner's responsibility, payment will be made as stated below unless other requirements are given in Specification Sections. Testing which is the responsibility of the Contractor will be considered an incidental item unless otherwise indicated in Section 01150, Measurement and Payment.
2. Initial Testing: Owner will pay for initial tests.
3. Retesting: Costs of retesting due to non-compliance will be paid by Owner. The cost of retesting will be determined by Engineer and Owner will invoice

Contractor for this cost. If unpaid after 60 days, the invoice amount will be deducted from the Contract Price.

4. Contractor's Convenience Testing: Inspections and tests performed for Contractor's convenience will be paid for by Contractor.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION

SECTION 01546

USE OF EXPLOSIVES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:
   1. Drilling, blasting, and removal of all ledge within the limits of excavation as indicated on the Contract Drawings.
   2. Pre-blast and post-blast surveys of existing structures and utilities.
   3. Seismic monitoring and documentation of all blasting.
   4. Obtain a blasting permit from the City of Portsmouth. Permit form is available online at https://portsmouthnh.viewpointcloud.com/

B. Related Work Specified Elsewhere (When Applicable):
   1. Section 02200 Earthwork
   2. Section 02156 Temporary Excavation Support System
   3. Section 02140 Temporary Dewatering System
   4. Geotechnical Data Report is provided in Appendix A.

1.2 REFERENCES

A. NFPA 495 (2010) - Explosive Material Code

B. US Department of Interior Bureau of Mines – Structure Response and Damage Produced by Ground Vibration from Surface Mine Blasting (RI 8507)

C. Occupational Safety and Health Administration (OSHA) 29 CFR 1910.109 Explosives and Blasting Agents

D. State Blasting Regulations

E. Local Blasting Regulations – City of Portsmouth's Blasting Rules and Procedures, which are included in Appendix B.

1.3 QUALITY ASSURANCE

A. Perform all blasting operations, including, but not limited to transportation, storage, handling, use and disposal, in accordance with all applicable Local, State and Federal laws, ordinances and code requirements, including NFPA 495, 29 CFR 1910.109, and State of New Hampshire Department of Transportation Standard Specifications for Road and Bridge Construction (latest revision), unless otherwise specified herein.
   1. Blasting shall follow the most restrictive laws, ordinances, and code requirements.

B. All blasting operations shall be performed by a single firm.

C. Qualifications:
   1. Blasting Subcontractor:
      a. Shall possess a current blasting license issued by the appropriate regulatory authority within the project state.
      b. Shall have a minimum 5-years' experience on similar blasting projects.

2. Seismic Monitoring Subcontractor:
    a. Shall be experienced in the use of seismographs and interpreting the information recorded.
    b. Shall have a minimum 5 years' experience on similar blasting projects.
    c. shall be selected and employed by the General Contractor.
    d. may be the Blasting Subcontractor, upon approval of the Engineer.
3. Pre-Blast and Post-Blast Survey Subcontractor:
    a. Shall be experienced in conducting pre-blast and post-blast surveys and documenting existing conditions of structures, buildings, utilities and monuments.
    b. Shall have a minimum 5 years' experience on similar projects.
    c. Shall be selected and employed by the General Contractor**.**

D. The Blasting Subcontractor shall secure and pay for all necessary blasting permits and furnish proof of permitting by all Local and State departments having jurisdiction.

E. A Pre-Blast Meeting shall be conducted, at the discretion of the Owner and Engineer, by the Blasting Subcontractor to discuss blasting procedures prior to the commencement of blasting operations. The meeting shall be attended by the Engineer, Owner, Blasting Subcontractor, Seismic Monitoring Subcontractor, pre-blast and post-blast Survey Subcontractor, City of Portsmouth Departments, and local utility companies (Eversource and Fairpoint Communications).

1.4 SUBMITTALS

A. Submit qualifications of the Blasting Subcontractor, Seismic Monitoring Subcontractor and Pre-Blast/Post-Blast Subcontractor, including the names and qualifications of the individuals who will be directly responsible for the work.

B. Blasting Subcontractor – proof of liability insurance and permitting shall be submitted prior to mobilization of blasting materials.

C. Submit blasting plan prior to the commencement of the blasting operations. The blasting plan shall include the following:
1. All equipment that will be used in the blasting operations.
2. Methods of matting or covering the blast area in open excavations to prevent flyrock and excessive air overpressure (airblast), and dust and fume mitigation.
3. Diameter, spacing, depth and bottom of blast hole elevation. Amount of explosive used per hole, on each delay and the total for the blast.
4. Calculations of ground vibration at adjacent structures and/or monitoring locations based on the proposed blasting plan and distances to adjacent structures and/or monitoring locations.
5. Name and qualifications of individual responsible for the design of the blasting program.
6. Description of audible warning system to be used.

D. Submit a monitoring plan prepared by the Seismic Monitoring Subcontractor with the coordination of the Blasting Subcontractor. The monitoring plan shall include the following:
1. Specifications of proposed instruments used to monitor ground vibrations and air overpressure. Submit calibration documents from within the past year.
2. Plan indicating Blasting and Seismic Monitoring locations relative to existing buildings and/or other structures.

E. Submit copy of blasting permits prior to beginning blasting operations.
F. Submit pre-blast survey documentation/report.
G. Submit post-blast survey documentation/report.
H. All shop drawings shall submitted for information only.
I. For work on NHDOT highways, NHDOT may require their review of the above submittals, including but is not limited to, detailed blasting plans and procedures.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Explosive charges and detonation devices shall be of a type suitable for the intended use. The use of blasting materials shall meet the manufacturer's specifications and safety requirements.
B. Store all explosives in a secure manner, in compliance with all State and local laws and ordinances, and legibly mark all sch storage places. Storage shall be limited to such quantity as may be needed for the work underway.

PART 3 - EXECUTION

3.1 PRE-BLAST SURVEY

A. Prior to commencing blasting operations and prior to installing excavation support systems, perform a pre-blast survey shall be conducted, and may be attended by the General Contractor, Blasting Subcontractor, and Engineer.
B. The structures to be surveyed shall be within 250 feet in all directions from the edge of each blasting locale as shown on the seismic monitoring plan. Structures to be surveyed, and their distance from the blast site may be influenced by the blast design, predicted vibration level and site specific public relations requirements.
C. The pre-blast surveyor subcontractor shall follow all of the Owner's conditions listed in the Blasting Rules and Procedures for notifying property owners, which include but are not limited to, certified mailings, and at least three attempts over a minimum of 1-week period to contact property owners.
D. The pre-blast survey shall include color photographs and/or high definition videos of all structures, buildings (including items such as bridges, dams, etc.) and water supply wells within the pre-blast survey zone. The photos and videos shall include both the exterior of each building and structure and all accessible interior rooms of each building, at the discretion of the property owner. All photos shall have the date permanently imprinted on the image.
E. Prior to blasting, all wells shall be documented and tested as follows:
    1. Flow test to measure the yield.
    2. Water quality tests by a State certified laboratory for bacteria and turbidity.
F. The Owner will coordinate access for survey work on adjacent properties.
G. The Pre-Blast Survey Subcontractor shall submit a final report, which shall include the following:
    1. Dated photographs with written identification of each, and/or high definition video of all buildings and other structures surveyed.

2. A written report shall be submitted a minimum of one week prior to commencement of blasting operations or excavation support system installation. The report will be made available to property owners on an as needed basis, with the cost borne by the Owner. The report shall include the following for each building, other structure, and wells:
   a. Location and description.
   b. Description of the overall condition.
   c. Noted physical deficiencies, cracks, pertinent elevations and other physical conditions that could be potentially affected by blasting operations.
   d. Yield and water quality test results of each water supply well.

3.2 PERFORMANCE - GENERAL

A. Drilling and blasting materials and methods shall be those necessary to accomplish ledge excavation required for completion of the work indicated on the Contract Drawings.

B. Blasting shall not commence until the pre-blast survey has been completed and submitted.

C. Blasting shall not commence until approval is received from the Owner for local roads. For NHDOT highways, blasting shall not commence until approval is received from both NHDOT District 6 Engineer and the Owner.

D. All explosives shall be stored and handled in a secure manner, in compliance with all Local, State and Federal laws, ordinances, and code requirements. Storage locations shall be legibly marked (vehicles placarded), and daily-use quantities limited to such quantities as may be needed for the current workday, including those necessary for changing site conditions. Explosives shall not be stored on site during non-working hours.

E. All blasting shall be performed in accordance with all Local, State and Federal laws, ordinances and code requirements.

F. All blasting areas shall be properly identified with appropriate signs or identification markers as required by law. Blasting signs notifying those approaching the blast site shall be placed at each entrance to the site or blasting area. Blasting notification signs shall be left in place while the above conditions prevail. Immediately remove signs after blasting operations have been completed.

G. All blasting shall be conducted within the hours of a.m. – 4 p.m. from Monday through Friday, excluding state and federal holidays. Any and all blasting outside of these time limits shall be subject to approval from the Owner, and shall be in compliance with all Local, State and Federal laws, ordinances and code requirements.

H. All safety precautions shall be taken to protect individuals in the direct vicinity of the blasting operations. Blasting mats or other means to prevent flying rock shall be utilized.

I. Conduct blasting operations such that damage is prevented to adjacent buildings, other structures, water supply wells, public domain, natural resources and habitat. Acceptable peak particle velocity limits and peak air overpressure limits shall not be exceeded.

J. General Contractor shall notify each abutting property owner and public utility company with buildings or other structures within a minimum 500-foot radius of the site work at least 10 days prior to initiating pre-blast surveys to enable the owners to take such steps as they may deem necessary to protect their property. The Contractor shall send the notification by certified mail with copies of the letters to be sent to all of the City's Departments listed in the City's Blasting Rules and Procedures, The actual blasting program to be implemented may require notification beyond the 500-foot radius. Notice shall be published in a local paper no more than 30 days and no less than 10 days prior to the initiation of the blasting.

K. General Contractor shall notify the Engineer at least 72 hours prior to commencing blasting operations.

L. An audible warning system shall be employed to warn all persons on site of blasting operations. Do not perform blasting work until the area is cleared and secure. Take appropriate precautions to prevent individuals from entering the blasting area. Provide sufficient flagmen outside the danger zone to stop all approaching traffic and pedestrians. The audible system shall include a warning that blasting is to commence, and notification that blasting is complete. Signs explaining the audible warning system shall be posted prior to blasting.

M. When blasting in areas where rock removal is required adjacent to and below existing structures, care shall be taken at the excavation limits to minimize over-blasting (back break or side break) and fracturing of remaining rock. Hydraulic hammer line drilling, presplit, or other means may be required to minimize the impact to the remaining rock relative to the site-specific conditions and geologic structure.

N. Perform at least one controlled test blast prior to commencement of production blasting in order to substantiate, or if necessary adjust, the proposed blast design to ensure vibration and overpressure limits are not exceeded. Coordinate scheduling of test blast/s with Engineer.

3.3 VIBRATION CONTROL

A. All blasting operations shall be conducted to limit ground vibrations to acceptable limits to help ensure that adjacent structures and buildings are not damaged.

B. Acceptable ground vibration limits shall be:

1. The following vibration limits, Peak Particle Velocity (PPV) in inch/sec, shall be adhered to based upon the USBM Alternative Blasting Level Criteria (adopted from RI 8507, 1980) relative to vibration frequency of blasts:
    a. Greater than 40 Hz - Maximum PPV = 2.0 in/s
    b. Greater than 30 Hz but not more than 40 Hz - Maximum PPV = 1.5 in/s
    c. Greater than 20 Hz but not more than 30 Hz - Maximum PPV = 1.0 in/s
    d. Not more than 20 Hz - Maximum PPV = 0.5 in/s

C. The peak air overpressures measured at the nearest above grade occupied structure shall not exceed 133 dB (0.014 psi).

D. Blasting shall not be permitted less than 72 hours after completion of any and all concrete placements within 250 feet and has 33% of its 28-day design strength.

E. Adherence to the above listed limits shall not relieve the Contractor of the responsibility to protect existing structures.

F. If these values are exceeded, Contractor shall stop blasting and submit a revised blasting plan. The revised blasting plan shall indicate why the limits were exceeded and indicate what changes will be made to prevent future exceedances.

3.4 BLASTING DOCUMENTATION (BLAST LOGS)

A. The Blasting Subcontractor shall prepare and maintain copies of all blasting logs which shall include, but not be limited to, the following information:
   1. Date, time and location of blast.
   2. Diagram of blast pattern showing the number, diameter, depth, subdrill, distribution, and powder factor for the explosives used per hole and per blast.
   3. Sequence and schedule of blasting rounds and delay pattern.
   4. Blast evaluations.
   5. Weather and temperature conditions.

B. For each blast at all blast sites, the Seismic Monitoring Subcontractor shall monitor the blasting vibrations and overpressures at a minimum of two buildings or other structures within 250 feet of each blast. This may be adjusted dependent upon the blast design and site-specific conditions as deemed necessary. One monitoring location shall be the nearest structure. Monitoring locations shall preferably be in different directions from the blast. The buildings or other structures to be monitored shall be mutually agreed upon by the Engineer, General Contractor, and Blasting Subcontractor. Blast monitoring shall commence just before the blasts are set off. Record vibration and overpressure measurements, which shall include, but not be limited to:
   1. Identification of monitoring instrument, and serial number.
   2. Calibration certificate dated within the past year.
   3. Name of instrument operator.
   4. Building or other structure at which the monitoring instrument is located, and distance from such structure.
   5. Distance and direction of monitoring instrument from blast site.
   6. Date and time of reading.
   7. Type of ground at recording station.
   8. Peak particle velocity and frequency for all components (vertical, radial and perpendicular).
   9. Values of air overpressure.
   10. Printed copies of measurement readings.
   11. Blast vibration and air overpressure measurement records shall be made available to Owner and Engineer on a weekly basis as deemed necessary, or as requested.

C. Crack Monitors:
   1. Where required, crack monitors shall be installed by the Seismic Monitoring Subcontractor. They may be required on structures that are within the zone of displacement or heave of the blast (within 20 feet), and/or at cracks in concrete and/or masonry that are greater than 1/16 inches (1.6 mm) wide and within 250 feet of the blast area. Crack monitor locations shall be as determined by the Engineer, Contractor, Blasting Subcontractor, or Seismic Monitoring

Subcontractor. All crack monitors shall be documented on plans of the buildings or structures with reference numbers for each monitor.

2. All cracks shall be measured and documented prior to commencement of blasting. Crack widths shall be measured to the nearest 0.10 millimeters.
3. Crack monitors shall be installed at the following locations:
   a. Sagamore Creek bridge (multiple locations)

D. Video Recording of Blasts:
   1. Contractor shall digitally record each blast from two locations approximately perpendicular to one another. The recordings shall be named to identify the blast. Contractor shall maintain a library of all video recordings.

3.5 POST-BLAST SURVEY

A. After conclusion of all blasting work, perform a post-blast survey shall be conducted at all building, structures and water supply wells that were part of the pre-blast survey. The survey may be attended by the General Contractor, Blasting Subcontractor, Engineer, and Owner. A report comparing the pre and post-blast conditions shall be provided.

3.6 DAMAGE TO STRUCTURES AND BUILDINGS

A. The General Contractor shall be responsible for all damages caused by blasting operations regardless of the adherence to specified vibration limits.

B. Such damage shall be repaired by the General Contractor at no additional cost to the Owner. The General Contractor shall submit proposed repairs, which shall be reviewed by the Engineer with no exceptions taken. Damages shall be defined as:
   1. Physical damage to the structure or building.
   2. Newly formed cracks in concrete or masonry.
   3. Substantial increase in width and/or length of existing cracks in concrete or masonry.
   4. Structure or building movement.
   5. Reduction in water supply well yield or water quality.

C. The extent of damages caused by blasting operations shall be determined by the Engineer. The Engineer will notify the General Contractor in writing of all damages caused by blasting operations. Disputes shall be resolved based on review of the pre-blast and post-blast surveys, seismic readings, etc.

END OF SECTION

SECTION 01562

DUST CONTROL

PART 1 - GENERAL

1.1 DESCRIPTIONS

A. Work Included:
   1. Furnish and apply water or calcium chloride on the road surfaces within the construction site, when required to control dust and when directed by the Engineer.
   2. When dust control is not included as a separate item in the Contract, the work shall be considered incidental to the appropriate items of the Contract.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Water for Sprinkling:
B. Clean, free of salt, oil, and other injurious matter.
C. Calcium Chloride:
   1. Meet the requirements of AASHTO M144.

PART 3 - EXECUTION

3.1 APPLICATION

A. Water:
   1. Apply water by methods approved by the Engineer.
   2. Use approved equipment including a tank with gauge equipped pump and spray bar.
B. Calcium Chloride:
   1. Apply at a rate sufficient to maintain a damp surface but low enough to assure non-contamination of water courses.
   2. Apply water prior to calcium chloride addition.

END OF SECTION

SECTION 01570

TRAFFIC REGULATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:
   1. Provide all materials and perform all work necessary to completely regulate traffic in the area of Work.
   2. Perform all work in such a manner as to provide safe passage at all times for the public and with a minimum of obstruction to traffic.
   3. Do not close roads or streets to passage of the public without the permission of the proper authorities.

B. The local police department and/or the New Hampshire Department of Transportation will decide if safe passage is being maintained and shall have the authority to require the Contractor to take any additional steps necessary to maintain safe passage. If the Authority furnishes an inspector on the job as a result of poor traffic control by the Contractor, the Contractor shall be responsible for all costs assessed by the Authority (State Highways).

C. Minimize the length of delays or traffic stoppage to the extent practicable. Maximum traffic stoppage time shall be 10 minutes.

D. Develop a project specific traffic control plan that meets the requirements of Manual of Uniform Traffic Control Devices (MUTCD) and any local and state requirements. Proposed Traffic Control Plan shall indicate signs/locations to be used. Traffic Control Plan submittal to the Engineer will be for general information only.

E. The Contractor's designated traffic control representative shall respond to all traffic safety complaints and be available to direct traffic control subcontractors the entire time work is occurring on site. If the designated representative is not on site for a period of time, another on site representative shall be designated by the Contractor for that period.

1.2 SCHEDULING WORK

A. During the Project Pre-Construction Meeting one Contractor representative will be designated as the coordinator between the Police Department and subcontracted traffic control.

B. Variable Message Signs notifying the public of pending road closure and/or construction must be in place seven days prior to road closure or as required by NHDOT.

C. Schedule all work so that two adjacent parallel streets are not closed to passage by the public at any one time, if at all possible.

D. Revise the plan of work if it will create a traffic hazard or an unreasonably long detour.

E. Do not start work in any new location without the permission of the Engineer.

F. Notify all police and fire departments of all scheduled detours and when streets are reopened.

PART 2 - PRODUCTS

2.1 WARNING SIGNS AND BARRICADES

A. Traffic control (plans, methods and devices) shall be as outlined in Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) as published by U. S. Department of Transportation, and any local and state requirements.

B. Provide adequate warning signs, barricades, signal lights, flaggers/uniformed police officers, and take other necessary precautions for the safety of the public.

C. Provide and illuminate suitable warning signs to show where construction, barricades or detours exist.

D. Provide digital message boards at appropriate locations as determined by the local police department and/or the NHDOT to maintain safe passage of traffic and work zone.

E. Provide barricades of substantial construction and painted with a finish that increases visibility at night, as outlined in the MUTCD.

F. Keep signal lights illuminated at all barricades and obstructions from sunset to sunrise.

G. Maintain all necessary signs, barricades, lights, watchmen and other safety precautions during authorized suspension of the Work, weekends, holidays or other times when the Work is not in progress.

H. Contractor shall make periodic inspection throughout the day of the traffic control patterns, methods, signs and other devices to ensure that they are properly placed.

2.2 UNIFORMED POLICE OFFICER

A. A uniformed police officer is a police officer (local, county or state) on regular or special duty dressed in uniform with the necessary high visibility vest and apparel needed for traffic control.

B. Arrange the police detail with the local Chief of Police, County Sheriff, or State Police Captain depending on jurisdiction.

2.3 FLAG PERSON

A. A flag person is a trained and certified individual assigned specifically to the task of directing traffic and is outfitted in the necessary high visibility vest and apparel needed for traffic control.

B. Flag persons shall be provided by the Contractor.

PART 3 - EXECUTION

3.1 DETOURS

A. Provide, identify and maintain suitable detours when the project, or any part thereof, is closed to public travel.

B. When the closed part of the project is reopened, restore the detour area and any other disturbed areas to the original condition.

3.2 INCONVENIENCE TO RESIDENTS OF VICINITY

A. Whenever a traveled way is closed, perform the Work in such a manner that local travel, residents and businesses in the vicinity of the Work will be inconvenienced as little as possible.

B. Allow access to residents and abutting land owners along the project to driveways and other normal outlets from their property.

3.3 TRAFFIC CONTROL OFFICERS

A. Where required by the local, county or state police departments and/or when specified, traffic control officer shall be a Uniformed Police Officers in addition to certified flaggers.

B. The Contractor shall provide certified flag persons and all other traffic regulation as part of the Traffic Control lump sum item in the Bid Form. An allowance has also been included in the Bid form to provide reimbursement for Uniform Police Officers when provided as supplemental traffic control in addition to the flag persons, where required by the Owner or NHDOT.

END OF SECTION

SECTION 01580

PROJECT IDENTIFICATION AND SIGNS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:

1. Provide and erect sign(s) at the project site to identify the project and to indicate the applicable Federal and State Government Agencies that are participating in the development of the project.

B. Do not place, or allow the placement of, other advertising sign boards at the project site or along rights-of-way furnished for the project work.

1.2 REQUIREMENTS SPECIFIED ELSEWHERE

A. Additional Requirements are specified elsewhere including, but not necessarily limited to, General Conditions, Supplementary Conditions, and Division 1.

PART 2 - PRODUCTS

2.1 MATERIAL AND DESIGN

A. Construct a sign of 3/4-inch exterior grade, high density overlaid plywood or other material, approved by the Engineer, suitable for signs.

PART 3 - EXECUTION

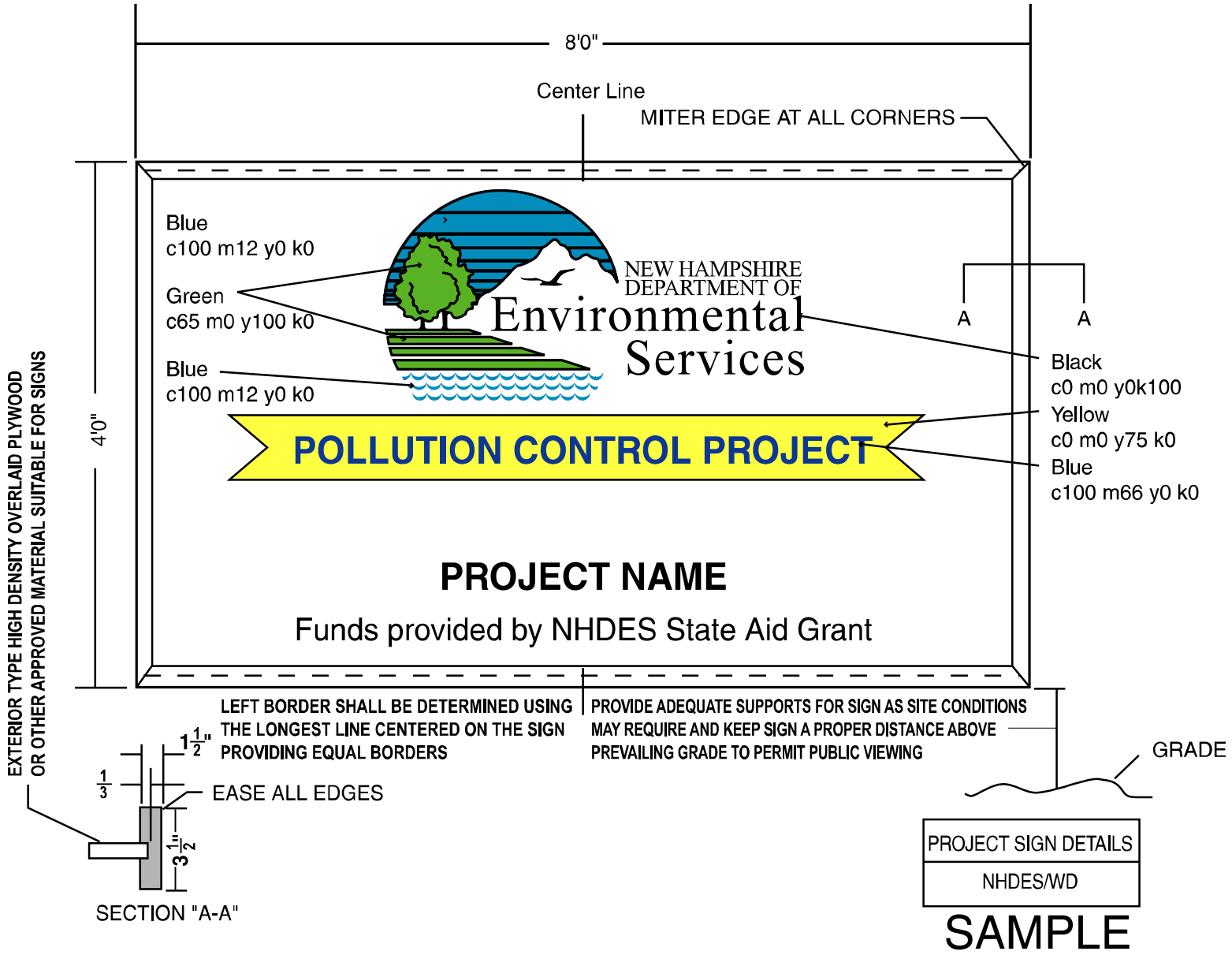
3.1 INSTALLATION

A. Erect the sign in a prominent location as approved by the Engineer.

B. Construct the sign in accordance with the following sample Drawing.

C. Remove the sign when the Work has been completed at no additional cost to the Owner.

END OF SECTION


8'0"
Center Line
MITER EDGE AT ALL CORNERS
4'0"
Blue
c100 m12 y0 k0
Green
c65 m0 y100 k0
Blue
c100 m12 y0 k0
NEW HAMPSHIRE
DEPARTMENT OF
Environmental
Services
POLLUTION CONTROL PROJECT
PROJECT NAME
Funds provided by NHDES State Aid Grant
A
A
Black
c0 m0 y0k100
Yellow
c0 m0 y75 k0
Blue
c100 m66 y0 k0
EXTERIOR TYPE HIGH DENSITY OVERLAID PLYWOOD
OR OTHER APPROVED MATERIAL SUITABLE FOR SIGNS
LEFT BORDER SHALL BE DETERMINED USING
THE LONGEST LINE CENTERED ON THE SIGN
PROVIDING EQUAL BORDERS
PROVIDE ADEQUATE SUPPORTS FOR SIGN AS SITE CONDITIONS
MAY REQUIRE AND KEEP SIGN A PROPER DISTANCE ABOVE
PREVAILING GRADE TO PERMIT PUBLIC VIEWING
GRADE
1 1/2"
1/3
EASE ALL EDGES
3 1/2"
SECTION "A-A"
PROJECT SIGN DETAILS
NHDES/WD
SAMPLE

SECTION 01600

DELIVERY, STORAGE AND HANDLING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies the general requirements for the delivery, handling, storage and protection for all items required in the construction of the work. An updated delivery and storage log is required with the monthly payment requisition prior to approval. An example log is included in this section.

B. Related Items:
   1. Section 01800: Equipment Start-Up, Certification and Operator Training.
   2. Section 11000: Equipment - General.

1.2 TRANSPORTATION AND DELIVERY

A. Transport and handle items in accordance with manufacturer's instructions.

B. Schedule delivery to reduce long term on-site storage prior to installation and/or operation. Under no circumstances shall equipment be delivered to the site more than 120 days prior to installation without written authorization from the Engineer.

C. Ship equipment, material and spare parts complete except where partial disassembly is required by transportation regulations or for the protection of components.

D. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended, including cross reference of the applicable contract specification section.

E. Deliver spare parts at the same time as pertaining equipment. Deliver spare parts to the Owner after completion of work.

F. Deliver products to the site in manufacturer's original sealed containers or other packing system, complete with instructions for handling, storing, unpacking, protecting and installing.

G. Instructions for handling, storing, unpacking, protecting and installing equipment shall be included in the Equipment O&M Manuals, which shall be submitted prior to the equipment being shipped to the site. This information shall be filed in a dedicated three ring binder(s) on-site, in the Contractor trailers, accessible to the Owner and Engineer. The binder(s) shall be clearly labeled, and include dividers for each specification section. The manufacturer-provided instructions for each equipment item shall be labeled with the specification number, equipment name, and equipment number. The instructions shall also be submitted to the Engineer.

H. Assume responsibility for equipment material and spare parts just before unloading from carrier at site.

I. All items delivered to site shall be unloaded and placed in a manner which will not hamper the Contractors normal construction operation or those of subcontractors and other contractors and will not interfere with the flow of necessary traffic.

J. Provide equipment and personnel to unload all items delivered to the site.

K. Promptly inspect shipment to assure that products comply with requirements, quantities are correct, and items are undamaged. For items furnished by others (i.e.

Owner, other Contractors), perform inspection in the presence of the Engineer. Notify the Engineer in writing of any problems.

L. Pay all demurrage charges if failed to promptly unload items.

1.3 STORAGE AND PROTECTION

A. Store and protect products and equipment in accordance with the manufacturer's instructions, with seals and labels intact and legible. Storage instructions shall be studied by the Contractor and reviewed with the Engineer by them. Instructions shall be carefully followed and a written record of this kept by the Contractor for each product and pieces of equipment.

B. Arrange storage of products and equipment to permit access for inspection. Periodically, inspect to make sure products and equipment are undamaged and are maintained under specified conditions.

C. Provide protective maintenance during storage consisting of manually exercising equipment, inspecting mechanical surfaces for signs of corrosion or other damage, lubricating, applying any coatings as recommended by the equipment manufacturer necessary for its protection and all other precautions to assure proper protection of all equipment stored and for compliance with manufactures requirements related to warranties.

D. Store loose granular materials on a solid flat surface in a well-drained area. Prevent mixing with foreign matter.

E. Cement and lime shall be stored under a roof and off the ground and shall be kept completely dry at all times. All structural, miscellaneous and reinforcing steel shall be stored off the ground or otherwise to prevent accumulation of dirt or grease, and in a position to prevent accumulations of dirt, standing water, staining, chipping or cracking. Brick, block and similar masonry products shall be handled and stored in a manner to reduce breakage, cracking and spalling to a minimum.

F. All mechanical and electrical equipment and instruments shall be covered with canvas and stored in a weather tight building to prevent injury. The building may be a temporary structure on the site or elsewhere, but it shall be satisfactory to the Engineer.

1. All equipment shall be stored fully lubricated with oil, grease and other lubricants unless otherwise instructed by manufacturer.
2. Moving parts shall be rotated at a minimum of once weekly to ensure proper lubrication and to avoid metal-to-metal "welding". Log all rotation maintenance for each piece of equipment in the written record noted above.
3. Upon installation of the equipment, the Contractor shall start the equipment, at least half load, once weekly for an adequate period of time to ensure that the equipment does not deteriorate from lack of use. Log all startup for each piece of equipment in the written record noted above.
4. Lubricants shall be changed upon completion of installation and as frequently as required thereafter during the period between installation and acceptance. New lubricants shall be put into the equipment at the time of acceptance.
5. Prior to acceptance of the equipment, the Contractor shall have the manufacturer inspect the equipment and certify that its condition has not been detrimentally affected by the storage period. Such certifications by the manufacturer shall be deemed to mean that the equipment is judged by the

manufacturer to be in condition equal to that of equipment that has been shipped, installed, tested and accepted in a minimum time period. As such, the manufacturer will guarantee the equipment equally in both instances. If such a certification is not given, the equipment shall be judged to be defective. It shall be removed and replaced at the Contractor's expense.

G. The weather tight building shall be provided with adequate heating/cooling and ventilation as required by the manufacturer to prevent condensation. Maintain temperature and humidity within range required by manufacturer and to prevent condensation on the equipment being stored.

H. Temporary heating and cooling is acceptable. Equipment shall be protected from environmental effects as required by the manufacturer and dependent on the season. Equipment that arrives on site without coating shall be protected from environmental impacts through coating or protection at the Contractor's expense. Any equipment that displays defects or corrosion from environmental impacts will not be accepted for installation.

I. The location of all stored material and equipment shall be reviewed with the Owner and Engineer. The Owner and Engineer may request that equipment and material be moved to an alternate location to accommodate plant maintenance and operation, or if the location is deemed unacceptable or unsuitable.

PART 2 - PRODUCTS - NOT APPLICABLE

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING MONTHLY LOG

A. An updated storage and delivery log is required with the monthly payment requisition prior to approval.

B. The monthly log shall include the specification section, equipment description, equipment tagging, submittal approval date, date of equipment delivery, date of O&M submittal, contractor start-up sign-off, certified equipment testing date, operator training date, spare parts turnover date, required maintenance (activity and date), and equipment turnover (Owner's witness and date).

3.2 STORAGE AND PROTECTION

A. Equipment requires acceptance and verification of the storage from the Owner, Engineer, Manufacturer and Contractor at the Engineer's discretion.

B. Following delivery, the equipment warranty from the Manufacturer is the responsibility of the Contractor.

C. All storage and maintenance will be the responsibility of the Contractor, conducted at the Contractor's expenses and verified by the Engineer.

D. It is the Contractor's responsibility to coordinate all storage requirements on site as required by the Manufacturer to achieve acceptance.

Section 01600 Delivery, Storage and Handling

Specification Section	Equipment Description	Equipment Tags	Submittal Approved	Date of Equipment Delivery[1]	Date of O&M Submittal	Equipment Start-Up[2]		Certified Equipment Testing	Operator Training	Spare Parts Turnover	Required Maintenance by Contractor (activity & date)	Equipment Turnover	
						Date	Witness	Date	Date	Date		Owner's Witness	Date

1. If equipment is delivered and placed in storage, all steps for Stored Equipment shall be followed and tracked separately
2. Log weekly start-ups of installed equipment, performed by Contractor, until Equipment Turnover

END OF SECTION

SECTION 01710

PROJECT CLEANING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:

1. Maintain premises and public properties free from accumulations of waste, debris, and rubbish, caused by operations.
2. At completion of work, remove waste materials, tools, equipment, machinery and surplus materials, and clean all sight-exposed surfaces. Leave project clean and ready for use.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Conduct cleaning and disposal operations in accordance with all applicable local and state laws, ordinances, and code requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Use only cleaning materials recommended by manufacturer of surfaces to be cleaned.

B. Use cleaning materials only on surfaces recommended by cleaning material manufacturers.

PART 3 - EXECUTION

3.1 PERFORMANCE

A. Cleaning During Construction:

1. Execute cleaning operations to ensure that buildings, grounds, and public properties are maintained free from accumulations of waste materials and rubbish.
2. Entirely remove and dispose of material or debris during the progress of the work that has washed into or has been placed in watercourses, ditches, gutters, drains, catch basins, or elsewhere as a result of the Contractor's operations.
3. Wet down dry materials and rubbish to lay dust and prevent blowing dust.
4. At reasonable intervals during the progress of work, clean the site and dispose of waste materials, debris, and rubbish.
5. Clean interiors of buildings, when applicable, prior to finish painting, and continue to clean on an as-needed basis until buildings are ready for occupancy.
6. Handle materials in a controlled manner with as few handlings as possible. Do not drop or throw material from heights.

7. When applicable, schedule cleaning operations so that dust and other contaminants resulting from the cleaning process will not fall on wet, newly painted surfaces.

B. Control of Hazards:
   1. Store volatile wastes in covered metal containers, and remove from premises daily.
   2. Prevent accumulation of wastes which may create hazardous conditions.
   3. Provide adequate ventilation during use of volatile or noxious substances.

C. Disposal:
   1. Do not burn or bury rubbish and waste materials on project site.
   2. Do not dispose of volatile wastes, such as mineral spirits, oil, or paint thinner, in storm or sanitary drains.
   3. Do not dispose of wastes into streams or waterways.

D. Final Cleaning:
   1. Employ experienced workmen, or professional cleaners, for final cleaning.
   2. Remove grease, dust, dirt, stains, labels, fingerprints, and other foreign materials, from all sight-exposed interior and exterior finished surfaces.
   3. Repair, patch and touch up marred surfaces to specified finishes.
   4. Broom clean paved surfaces.
   5. Rake clean non-paved surfaces of the project site.
   6. Restore to their original condition those portions of the site not designated for alterations by the Contract Documents.

END OF SECTION

SECTION 01720

PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:
   1. Keep accurate record documents for all additions, demolition, changes of material or equipment (from that shown on the Drawings), variations in work, and any other additions or revisions to the Contract (via Change Order, Work Change Directive, Field Order or Clarification).

B. Related Work Specified Elsewhere:
   1. Shop Drawings, Project Data, and Samples are specified in "General Conditions" and Section 01340, Submittals.
   2. Electrical System Record Drawing requirements are outlined in Section 16010.

1.2 MAINTENANCE OF DOCUMENTS

A. Maintain at job site, one copy of:
   1. Contract Drawings
   2. Specifications
   3. Addenda
   4. Reviewed Shop Drawings
   5. Change Orders
   6. Any other modifications to the Contract
   7. Field Test Reports

B. Store documents in files and racks specifically identified for Record Drawing use, that are apart from documents used for construction.

C. File documents in a logical manner indexed for easy reference.

D. Maintain documents in clean, dry, legible condition.

E. Do not use record documents for construction purposes.

F. Make documents available at all times for inspection by the Engineer and Owner, and by the end of the project, transmit these documents to the Engineer.

G. Failure to maintain current records, as specified herein, shall be grounds for withholding additional retainage from monthly partial payment requests.

1.3 RECORDING

A. Label each document "PROJECT RECORD" in large high printed letters.

B. Keep record documents current and do not permanently conceal any work until required information has been recorded.

C. General Field Recording Issues:
   1. All swing ties shall be taken from existing, permanent features such as utility poles, corners of buildings and hydrants. Porches, sheds or other house additions shall be avoided as they could be torn down. A minimum of two swing ties shall be taken. Survey grade GPS coordinates are also acceptable.
   2. Stations shall be recorded to the nearest foot.
   3. Inverts shall be recorded to the nearest hundredth of a foot.

4. Elevations shall be recorded to the nearest hundredth of a foot.
5. Building dimensions shall be recorded to the nearest 1/4".
6. Equipment and Piping shall be recorded to the nearest tenth of a foot, and the overall dimensions and layout of the equipment shall be adjusted to reflect the equipment provided.

D. Project Record Drawings - Legibly mark Contract Drawings to record existing utilities and actual construction of all work, including but not limited to the following (where applicable):
   1. Existing Utilities
      a. Water mains and services, water main gate valves, sewer mains and services, storm drains, culverts, steam lines, gas lines, tanks and other existing utilities encountered during construction must be accurately located and shown on the Drawings. In congested areas supplemental drawings or enlargements may be required.
      b. Show any existing utilities encountered in plan and profile and properly labeled showing size, material and type of utility. Ties shall be shown on plan. Utility shall be drawn to scale in section (horizontally and vertically) and an elevation shall be called out to the nearest hundredth of a foot.
      c. When existing utility lines are broken and repaired, ties shall be taken to these locations.
      d. If existing water lines are replaced or relocated, document the area involved and pipe materials, size, etc. in a note, and with ties.
   2. Manholes, Catch Basins, Valve Pits and other structures.
      a. Renumber structure stationing to reflect changes.
      b. Show ties to center of structure covers or hatches.
      c. In general, show inverts at center of structures. However, for manholes with drop structures, or steep channels (greater than 0.2' change on slope), show inverts at face of manhole.
      d. Show inverts for other structures at the face of the structure.
      e. Draw any new structures that are added on plan and profile.
      f. Show any field or office redesigns.
      g. Redraw plan if the structure's location is moved more than 5 feet in any direction. Note: It is important to show existing utilities, as outlined in Paragraph 1 above, especially if they were one reason for relocating the sewer, manholes and other structures.
      h. Redraw profile if inverts changed by more than 6 inches.
   3. Gravity Sewer Line
      a. Change sewer line slopes indicated on Drawings if inverts are changed.
      b. Draw any new gravity lines that are added on plan and profile.
      c. Show any field or office redesigns.
      d. Redraw the sewer line profile if manhole inverts are redrawn.
      e. Redraw the sewer line on plan corresponding to relocated manholes.
   4. Water Mains and Force Mains
      a. Show ties to the location of all valves, bends (horizontal and vertical), tees and other fittings. The use of thrust blocks shall be recorded.
      b. Revise elevations indicated on the Drawings to reflect actual construction.

5. House Services
   a. Draw all house services (even to empty lots) on plan and show ties.
   b. Show ties or distances to wyes from manhole.
   c. Show chimneys heights in the profile.
   d. The Wright-Pierce "Sanitary Sewer Service Location" forms and “Water Service Location” forms shall be used to record sewer and water service information. A copy of these forms shall be provided to the Owner, along with the Record Drawing Set.
6. Septic Tanks
   a. Show ties to center of tank covers.
   b. Label size of septic tanks that are other than standard 1,000-gallon capacity.
   c. The Wright-Pierce "Sanitary Sewer Service Location" forms shall be used to record septic tank information. A copy of these forms shall be provided to the Owner, along with the Record Drawing Set.
7. Ledge
   a. Ledge profiles shall be shown. Note whether the plotted ledge profile reflects undisturbed or expanded conditions.
8. Yard Piping and Buried Electrical Conduit
   a. Site piping and utilities shall be drawn to reflect the installed locations, with ties and elevation of all bends (horizontal and vertical).
   b. Show routing for electrical conduits and pull boxes, especially in close proximity to buildings and when the conduits change direction or cross process piping.
9. Roads
   a. Show centerline road profile and level spot elevations.
   b. Show pavement widths.
   c. On road cross sections, show the pavement cross slope.
   d. Show any deviations from the design plans.
10. Buildings
   a. In general, small changes to structures shall not be redrawn. If any dimensional changes were made in the field, the numerical change shall be made on the Drawing and be properly labeled. Update dimensions and elevations on Drawings.
   b. Show finished concrete elevations (top of slab, top of wall, top of footing, etc.). Redraw any foundation, frost wall, etc. that was modified, deepened, or altered during construction.
   c. Adjust finished concrete horizontal dimensions that are shown on the Drawings.
   d. Adjust structural steel elevations and horizontal dimensions that are shown on the Drawings.
   e. Show location of anchors, construction and control joints, and waterstops, when they are different from those shown on Drawings.
   f. Any additions or major changes shall be shown in both plan and elevation (i.e. relocated doors, opposite door swings, change in wall location, relocation of floor drains).

g. Show approximate location and routing of electrical conduits in walls, slabs and ceilings. Most conduits are run in groups, therefore, use range of measurements to define location for entire section of conduits.
h. Special circuits for computers, alarms and instrumentation shall be shown.
i. Show any changes in location and elevation of ductwork and devices, fuel piping and equipment, and heat piping and equipment.
j. Location of gravity sewer system below slabs in buildings shall be shown, if changes are made in the configuration.
k. If wall mounted electrical switches, control boxes, thermostats, etc. have been relocated significantly, (other side of door, or to a wall other than indicated diagrammatically on electrical plans) make the revision accordingly.

11. Utilities
    a. When encountered, additional utilities (e.g., gas, cable, telephone, fiber optic, etc.) shall be indicated on the Record Drawings.
12. Equipment Systems and Piping
    a. Show any changes to equipment systems, whether interior or exterior, for process, HVAC, plumbing, instrumentation or electrical. If any dimensional changes were made in the field, the numerical change shall be made on the Drawing and be properly labeled. Update dimensions and elevations on Drawings. Record Drawings must reflect any equipment configuration and layout changes differing from that shown on the Drawings.
    b. Show any changes to piping systems, whether interior or exterior, for process, HVAC, plumbing and instrumentation. If any dimensional changes were made in the field, the numerical change shall be made on the Drawing and be properly labeled. Update dimensions and elevations on Drawings.

E. Specifications and Addenda - Legibly mark up each section to record:
1. Manufacturer, trade name, catalog number, and supplier of each product and item of equipment actually installed.
2. Changes made by Change Order, Field Order, or other method.

1.4 SUBMITTALS

A. At the completion of the project, and prior to the release of retainage, deliver record documents to the Engineer.
1. Record drawings shall be provided as a bound paper set of computer-generated drawings, an electronic file (pdf format) of the bound paper set, and electronic files in AutoCAD format. Ownership of the drawings and files shall pass to the Owner at the time of submittal.
2. If the Contractor provides alternate or substitute equipment that requires revised arrangements from the Bidding Documents, the Contractor shall provide supplemental record drawings of these items in AutoCAD format.

B. Accompany submittal with transmittal letter, in duplicate, containing:
1. Date, project title and number.
2. Contractor's name and address.
3. Title and number of each record document with certification that each document is completed and accurate.

4. Signature of Contractor, or their authorized representative.

C. Failure to supply all information on the Project Record Drawings as specified in Part 1.3 may result in withholding final completion and in non-approval of final payments of the Contract. If Contract Time has elapsed, this shall be grounds for imposing liquidated damages.

1.5 QUALITY ASSURANCE

A. All horizontal and vertical dimensions, swing-ties, and elevations shall be accurate to within one-tenth of a foot, unless greater accuracy is specified elsewhere in the Specifications (e.g., concrete elevations, weir elevations, etc.).

PART 2 - PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION

3.1 MAINTAINING AND PROVIDING RECORDS

A. Records shall be kept current as the work progresses.

B. Records shall be made available for review by the Owner, Engineer, Resident Project Representative and/or Funding Agency(s) upon request.

C. Records shall be kept current as the work progresses. Failure to maintain current records, as specified herein, shall be grounds for withholding additional retainage from monthly partial payment requests. Failure to provide records shall also be grounds for withholding of final payment and, if beyond contract time, shall be grounds for imposing liquidated damages.

3.2 AS-BUILT SURVEY PERFORMANCE

A. From established survey control, and construction baseline as shown on the drawings, conduct surveys of the project area during construction as needed to obtain information of buried and above ground items. Surveys shall include information outlined in Section 1.3.

B. Actual road alignments; walls; fence and guardrail; existing, new and relocated utility poles; traffic and warning sign locations; crosswalks, parking space and stop bar locations; retaining walls and foundations drains; all underground and overhead utility poles and lines within the project limits, including those installed on private property; all other new features and appurtenances and those existing features and appurtenances changed as a result of this project shall be included in the survey.

3.3 FORMAT FOR ELECTRONIC DELIVERABLES

A. AutoCAD digital survey data for the as-built survey shall include:

1. Copy of field notes and sketches of the survey.
2. Paper copy of description of layers.
3. Paper copy of base map.
4. Provide digital information on compact disk with paper copy printout; information shall be provided in .DWG format (AutoCAD 2011 or earlier). Data shall be provided in 3D format (northing, easting, elevation, or Y, X, Z).

5. Drawing scale: Minimum one inch = twenty feet.
6. Layering:
    a. Repetitive symbols made into blocks and defined on layer 0.
    b. All entities shall be drawn “by layer” as opposed to individual properties.
    c. Use one linetype and one color per layer as opposed to numerous colors/linetypes on a single layer.
    d. Preface each layer with the initials of the Survey company or Contractor (example, Survey Company: SC “layername”).
    e. Database text annotation will be coordinated so the text will be right-reading.
    f. Place text on separate layers.

END SECTION

SECTION 01800

EQUIPMENT STARTUP, TESTING AND OPERATOR TRAINING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:

1. General: The work of this Section includes the startup, certification and operator training of equipment and control systems sufficient for a fully functional project as determined by the Engineer. The following steps are integral to this process:
   a. Submittals, as specified in Section 01340.
   b. Operations and Maintenance Manuals, as specified in Section 01340.
   c. Summary of Work/ Construction Sequencing as specified in Section 01010.
   d. Pre-Startup Meeting, as specified herein.
   e. Factory Acceptance Testing, as specified in Division 13.
   f. Equipment Startup, as specified herein.
   g. Operator Training, as specified herein.
   h. Equipment Demonstration Testing, as specified herein.
   i. Site Acceptance Testing, as specified in Division 13.
   j. One Year Service Calls, as specified herein.

B. General Definitions:

1. Equipment Startup shall be generally defined as the initial placing into service of the equipment by representatives of the Contractor, any subcontractors directly responsible for the equipment provided, and the equipment Manufacturer. This shall include verification of all equipment protection and safety control features (e.g., motor high temperature, seal fail, hardwire interlocks, estops, etc.) and include configuration of the VFD (if applicable) prior to equipment startup.
2. Equipment Demonstration Testing shall generally be defined as the formal and scheduled demonstration of equipment/system operations in accordance with the requirements of the Contract Documents, including all required performance or acceptance testing. This formal demonstration shall be performed in the presence of the Engineer by representatives of the General Contractor, any Subcontractors directly responsible for the equipment provided, and the equipment Manufacturer.
3. Operator Training shall generally be defined as the formal and scheduled instruction of plant personnel and other Owner designated representatives in the proper operations of provided equipment, and in the techniques, methods, schedules, etc. associated with maintenance. This formal training shall be performed in the presence of the Engineer, by representatives of the Contractor, any subcontractors directly responsible for the equipment provided, and the equipment Manufacturer. Operator Training shall also include remote

assistance to plant personnel by Manufacturer representatives during the initial operations of the equipment.

C. Related Work Specified Elsewhere:
   1. Process equipment/systems are specified in Division 11.
   2. Instrumentation and control systems are specified in Division 13.
   3. Plumbing Systems are specified in Division 15.
   4. Electrical systems are specified in Division 16.

D. Submittals:
   1. In accordance with the requirements of Section 01340.
   2. Contractor shall coordinate with subcontractors and Manufacturers and provide a proposed start-up, testing and training plan for each piece of equipment including detailed plans for temporary bypass pumping or temporary facilities, when required.
      a. The startup, testing and training plan shall include a written outline description of the means and methods to be employed during the certified equipment test of each piece of equipment as well as the anticipated sequence and duration of activities.
      b. The startup, testing and training plan shall include the name(s) and resume(s) of the duly authorized Manufacturer's Representatives proposed for the project. The qualifications of duly authorized representatives of the Manufacturer are identified in Paragraph 1.2 below.
      c. The startup, testing and training plan shall include proof of calibration of decibel meter(s) and flow meter(s) to be used in Equipment Startup(s).
      d. The startup, testing and training plan shall comply with the sequencing and scheduling requirements outlined in Section 01010.
      e. The startup, testing and training plan shall identify the location and type of temporary flow meters to be utilized, where required herein.
      f. Equipment startup and testing shall not be scheduled for Fridays without prior agreement by the Owner and Engineer.
      g. Contractor shall assume a maximum of 3 days per week of availability by the Engineer for equipment startup, training and demonstration testing. Availability beyond this will be considered on a case-by-case basis with prior agreement by the Owner and Engineer.
      h. Contractor shall revise and resubmit the startup, testing and training plan to reflect the discussions and requirements from the Pre-Startup Meeting.
      i. Contractor shall submit manufacturer Operations and Maintenance Manuals, along with updated control system drawings, at least 2 months prior to Equipment Startup.
   3. Contractor shall submit updated system-specific startup, testing and training plans a minimum of 14 days prior to individual system starts, based on discussions at the Pre-Startup Meeting and subsequent coordination with Manufacturers, RPR and Owner (e.g., process availability, equipment status, valving, lockout/tagout, etc.). Refer to schedule and notification requirements below.

4. Following successful Equipment Startup, Operator Training and Equipment Demonstration Testing, submit:
    a. Completed Equipment Startup Certification forms
    b. Completed VFD Parameter Setup Checklist and VFD Parameter Setup Verification forms
    c. Completed Operator Training forms
    d. Completed Equipment Demonstration Testing Certification forms

E. Schedules and Notifications:
1. Contractor shall provide Engineer with at least a 14 calendar day notice prior to initiating startup activities to allow necessary coordination with Engineer and Owner representatives. If startups are conducted in groups of activities, the notification shall be provided for each grouping. The actual date and time for testing and/or training will be the first mutually acceptable date and time available to all parties subsequent to receipt of the request.
2. Contractor shall be responsible for any and all coordination necessary with the daily operations of the facility to accommodate the testing schedule.
3. Operator Training shall follow successful Equipment Startup and must be completed prior to the equipment being put on-line for uninterrupted service. Contractor may formally request that Operator Training be conducted concurrently with the Equipment Demonstration Testing; however, this determination will be made on a case-by-case basis by the Engineer and Owner. Under no circumstances will conditions of the testing interfere with the ability of Owner's representatives to observe necessary features, to hear and understand instructions, or to ask questions. If such conditions occur, then Operator Training will not be allowed to run concurrently with Equipment Demonstration Testing.
4. Contractor shall maintain a shared calendar for the Owner, Engineer and Contractor to document the agreed upon dates for individual Equipment Startup, Operator Training, and Equipment Demonstration Testing.

1.2 QUALITY ASSURANCE

A. Duly authorized Manufacturer’s Representatives shall meet the following criteria:
1. A direct employee of the Manufacturer;
2. Fluent in the English language;
3. Has a minimum of 5 years of experience in the proper installation, adjustment, operation, testing, and startup of the specified model, including, but not limited to, equipment calibration, and other mechanical or electrical components of the equipment.
4. Sales personnel, marketing personnel or local representatives will not be accepted as a duly authorized representative of the Manufacturer unless the Manufacturer has certified them accordingly.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

3.1 EQUIPMENT STARTUP

A. Equipment startup shall be performed by the authorized representative(s) of the Manufacturer as identified in the Submittals.

B. The Equipment Startup shall be performed prior to Operator Training and prior to Equipment Demonstration Testing.

C. No form of energy shall be applied to any part of the system prior to receipt by the Engineer of a certified statement of approval of the installation from the Contractor. This certification shall contain a statement by an authorized representative of the equipment Manufacturer that the equipment is ready for testing, as outlined below.

D. As part of the Equipment Startup, the Contractor and Manufacturer shall:

1. Verify that the equipment is installed properly and in accordance with Manufacturer's requirements and instructions, and as such, it is appropriate to apply power to the units in question.
2. Verify that all manual and all automatic equipment protection and safety control features of the equipment function properly, including all alarms, and all activation and deactivation sequences.
3. Verify that the equipment can operate without excessive noise, vibration, overheating, overloading, jamming, etc. during specified conditions.
4. Verify and document equipment capacity and amperage draws (on all power feeds) with equipment running under specified conditions.
5. Verify and document the noise level of equipment, drives and motors, unless otherwise noted, shall not exceed 90 dBA, as measured 3 feet from the unit under free field conditions.
    a. Each unit shall be monitored for compliance running under specified conditions with other area equipment deactivated.
    b. Contractor shall provide certified proof of calibration for instrument utilized to measure noise level.

E. Each piece of equipment shall be tested sufficiently to ensure that all features required to be demonstrated and/or verified during the equipment certification testing are within acceptable limits. The startup shall not be considered complete until the unit is fully capable of passing the equipment certification testing.

F. Where multiple units are provided, each unit shall undergo startup procedures.

G. The duly authorized representative of the Manufacturer shall provide all specialty tools, specialty testing equipment and labor necessary for the start-up of the equipment.

H. The Contractor shall provide all power, chemical, tools, equipment, labor, water and fuel as required for Equipment Startup.

1. The Contractor shall be responsible for all contacts and arrangements as necessary with the proper municipal departments and/or public utility companies to arrange for temporary and/or separate billing so that bills associated with testing and startup procedures can be easily identified.
2. Contacts and arrangements with the local power company shall include, but not be limited to, all arrangements as necessary so that peak power demands incurred during testing and startup procedures will not become a part of the permanent record for determining future power demand charges for the Owner.

3. All waste materials shall be disposed of by the Contractor in an environmentally acceptable manner at no additional cost to the Owner.

I. In the event of an unsuccessful equipment start-up, Manufacturer and Contractor shall make necessary alternations, adjustments, repairs and replacements and the equipment start-up shall be repeated.

J. The Manufacturer Representative's shall fill out the Equipment Start-Up Certification form included at the end of this Section. Startup will not be considered complete until this form has been provided to the Engineer along with the Manufacturer Representative's field report.

3.2 EQUIPMENT DEMONSTRATION TESTING

A. Equipment Demonstration Testing shall be performed after the Equipment Startup is completed and it has been verified that equipment functions in accordance with the requirements of the Contract Documents in all aspects. Equipment Demonstration Testing shall be performed by the authorized representative(s) of the Manufacturer.

B. Equipment Demonstration Testing shall not be scheduled concurrently with Equipment Startup without the prior approval of the Engineer.

C. If the Engineer has arrived on-site for the scheduled Equipment Demonstration Testing and the equipment is not capable of demonstrating complete compliance with the Contract Documents, or if the Manufacturer's representative is not present, the Contractor shall be responsible for all costs to the Engineer associated with failed testing, including travel expenses. The importance of prior and proper equipment demonstrations to verify that the requirements of the Equipment Demonstration Testing will be met is stressed.

D. At a minimum during the Equipment Demonstration Testing, the Contractor shall complete the following to the satisfaction of the Engineer:

1. Demonstrate that the equipment is installed properly and in accordance with Manufacturer's requirements and instructions, and as such, it is appropriate to apply power to the units in question.
2. Demonstrate all manual and all automatic equipment protection and safety control features of the equipment functions properly, including all alarm, activation and deactivation sequences.
3. Demonstrate that the equipment can operate without excessive noise, vibration, overheating, overloading, jamming, etc. during normal operating conditions.
4. Demonstrate the full specified range of equipment operation when controlled remotely by the controls system.
5. Other specific requirements as outlined within the individual specifications sections.

E. Each piece of equipment shall be tested sufficiently to ensure that all features required to be demonstrated and/or verified are within acceptable limits.

F. Where multiple units are provided, each unit shall undergo equipment certification testing procedures individually and then with multiple units on-line to verify the total systems output capacity and performance.

G. The duly authorized representative of the Manufacturer shall provide all specialty tools, specialty testing equipment and labor necessary for the start-up and testing of the equipment.

H. The Contractor shall provide all power, chemical, equipment, labor, water and fuel as required for startup and testing.

I. All equipment provided on the project shall be demonstrated to function properly. Demonstration as a component of an overall system shall not relieve the Contractor of their responsibilities to demonstrate proper operation or verify specific requirements for each individual component.

J. Minimum Testing Requirements for Pumps:
   1. If sufficient sewage or water is not available for tests, Contractor will provide water at their expense for testing, if so directed.
   2. During tests, Manufacturer shall observe and record head, output, rpm, motor input and amperage. Sufficient test points shall be obtained to develop accurate pump system curve. If multiple operational points are specified, compliance with all points must be sufficiently demonstrated.
   3. If permanent and calibrated flow meters are not available, provide temporary and calibrated flow metering.
   4. Fully demonstrate ability to operate at specified conditions without motor overload.
   5. Refer to Section 11000, 11310 and 11319, as applicable, for additional details.

K. Minimum Testing Requirements for Instrumentation/Control Systems:
   1. All instruments shall be calibrated in the presence of the Engineer.
   2. All transmitters or direct-operated receivers shall be calibrated to impose input values representing zero percent, ten percent, and eighty percent of full scale.
   3. The inputs and outputs of devices, as appropriate, shall be connected to manometers for differential pressure devices, or compared to measured levels, rates or quantities, during calibration. The receiving devices shall be adjusted to read the calibrated output of the initial calibration.
   4. After placing each measuring system in service, an actual comparison of the measured variable versus readout shall be made. For each differential pressure based measuring system, a manometer shall be connected to the connections provided in the piping, tank, or other appropriate device. Each system shall meet the manufacturer's standard accuracy.
   5. Secondary functions, such as sequencing, timing features, alarm actuation and pacing shall be adjusted during initial calibration, demonstrated after the system is placed in service and adjusted during equipment demonstration testing, as necessary.
   6. Linkage or range adjustments shall be sealed by colored lacquer in the presence of the Engineer immediately following calibration.
   7. Process calibration, such as volumetric drawdown tests on flows and level measurements, shall be conducted on all measuring systems as requested by the Engineer. Once established as being within acceptable accuracy limits, future tests which require use of the measuring device to demonstrate system operations can utilize generation of mA signals to simulate level, flow or similar variable variations.
   8. Refer to Division 13 for additional details.

L. Minimum Testing Requirements for Electrical Systems.
   1. Refer to Section 16000, 16620 and 16950.

M. In the event of unsuccessful Equipment Demonstration Testing, Manufacturer and Contractor shall make necessary alternations, adjustments, repairs and replacements and the equipment testing shall be repeated.

N. The Manufacturer Representative's shall fill out the Equipment Demonstration Testing Certification form included at the end of this Section. Equipment Demonstration Testing will not be considered complete until this form has been provided to the Engineer along with the Manufacturer representative field report.

3.3 OPERATOR TRAINING

A. Operator Training shall be performed by the authorized representative(s) of the Manufacturer as identified in the Submittals.

B. Unless otherwise noted within the specific specification sections, provide minimum of one day (8-hour days, not including travel time) of combined training and operational assistance for plant operators for each piece of equipment in the proper operations of provided equipment, and in the techniques, methods, schedules, etc. associated with maintenance.

C. The level of the training and operational assistance provided shall be as required to ensure proper understanding of the equipment's operations, maintenance and warranty conditions. Should manufacturer require time in addition to the minimums indicated herein, or within the individual specification sections, to sufficiently detail the proper operations and maintenance of the equipment, it will be provided at no additional cost to Owner. Under absolutely no circumstances shall warrantees become void due to Owner's failure to follow operational and maintenance procedures which were not fully detailed and described to Owner's representatives during these sessions.

D. Refer to individual equipment specification sections for further requirements.

E. The manufacturer representative shall fill out the Operator Training Certification form included within this Section. Training will not be considered complete until this form has been provided to the Engineer.

EQUIPMENT START-UP CERTIFICATION

Owner: _____ Date: _____

Project _____

Contractor: _____

Equipment Manufacturer: _____

Equipment: _____

Specification Number: _____

As an authorized representative of the equipment manufacturer, the undersigned certifies that the equipment listed above conforms to the requirements of the Contract Documents. The undersigned authorized representative of the manufacturer further certifies that the equipment has been installed in accordance with the manufacturer's written instructions, that it is ready for permanent operation and that nothing in the installation will render the manufacturer's warranty null and void.

_____ _____
(Manufacturer's Authorized Representative/ Signature & Printed Name) (Date)

_____ _____
(Contractor/ Signature & Printed Name) (Date)

_____ _____
(Witnessed by Engineer/ Signature & Printed Name) (Date)

** Manufacturer's Representative to provide a copy of Field Report via separate transmittal **

OPERATOR TRAINING CERTIFICATION

Owner: _____ Date: _____

Project _____

Contractor: _____

Equipment Manufacturer: _____

Equipment: _____

Specification Number: _____

I, the undersigned Manufacturer's Authorized Representative, have trained the Owner's personnel listed below in the proper operation and maintenance of the above listed equipment.

_____

_____

_____

_____

_____

_____ _____
(Manufacturer's Authorized Representative/ Signature & Printed Name) (Date)

_____ _____
(Owner's Representative/ Signature & Printed Name) (Date)

_____ _____
(Witnessed by Engineer/ Signature & Printed Name) (Date)

EQUIPMENT DEMONSTRATION TESTING CERTIFICATION FORM

Owner: _____ Date: _____

Project _____

Contractor: _____

Equipment Manufacturer: _____

Equipment: _____

Specification Number: _____

This certifies that the entire equipment/system has met the requirements of Section 01800, 16950 and all other applicable requirements of the contract documents.

_____ _____
(Manufacturer's Authorized Representative/ Signature & Printed Name) (Date)

_____ _____
(Contractor/ Signature & Printed Name) (Date)

_____ _____
(Witnessed by Engineer/ Signature & Printed Name) (Date)

** Manufacturer's Representative to provide a copy of Field Report via separate transmittal **

END OF SECTION

SECTION 02076

ASBESTOS-CEMENT (TRANSITE) PIPE REMOVAL AND DISPOSAL

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Remove and dispose of Asbestos-Cement (AC) sewer main according to all applicable Federal, State, and local laws, regulations, and ordinances.

1.2 SCHEDULING

A. Prior to initiating AC pipe removal, the Contractor shall prepare an abatement plan and provide a copy for record purposes to the Engineer. Refer to section 1.5 SUBMITTALS for more information.

B. The Contractor shall update the abatement schedule as requested by the Engineer.

1.3 CODES, REGULATIONS, AND STANDARDS

A. General Applicability

1. Contractor shall perform all work in accordance with these specifications: U.S. Environmental Protection Agency (U.S. EPA) and Occupational Safety & Health Administration (OSHA) regulations, NIOSH recommendations, New Hampshire Department of Environmental Services (NHDES) rules and regulations, and any other applicable Federal, State and local government regulations and guidelines
2. The most recent edition of any relevant regulation, standard, document, code or policy statement shall be in effect. Where conflict among the requirements or with these specifications exists, the most stringent requirement(s) shall be utilized.

B. Contractor Responsibility

1. The Contractor shall assume full responsibility and liability for compliance with all applicable Federal, State and local regulations related to all aspects of the abatement project. The Contractor is responsible for providing and maintaining training, accreditation, medical exams, medical records, and personal protective equipment as required by applicable Federal, State and local regulations. The Contractor shall hold the Owner and Owner's Representative harmless for any failure to comply with any applicable work, packaging, transporting, disposal, safety, health, or environmental requirement on the part of the Contractor, Contractor's employees, or subcontractors of the Contractor.

C. The publications listed below form a part of this specification to the extent referenced. The publications listed below are not intended to be a comprehensive list of all regulations, applicable to this work.

1. Environmental Protection Agency (EPA):
    a. National Emission Standards for Hazardous Air Pollutants (NESHAP) Title 40, Part 61).
    b. A Guide to Respiratory Protection for the Asbestos Abatement Industry.

2. Occupational Safety and Health Administration (OSHA):
   a. Asbestos Construction Standard 29 CFR Part 1926.1101
   b. Asbestos General Industry Standard 29 CFR 1910.1001
   c. Respiratory Protection, 29 CFR 1910.134
   d. Construction Industry Standards, 29 CFR 1926
3. U.S. Department of Transportation
   a. 49 CFR 100 - 185, Transportation
4. National Institute for Occupational Safety and Health (NIOSH):
   a. "Respiratory Protection A Guide for the Employee."
5. American National Standards Institute (ANSI):
   a. Z86.1-1973 - Commodity Specification for Air
   b. Z9.2 - HEPA Filter Specifications
   c. Z88.2-1980-Respiratory Protective Equipment
6. New Hampshire Department of Environmental Services (NHDES):
   a. Chapter Env-A 1800 Asbestos Management and Control
   b. Chapter Env-Sw 800 Landfill Requirements
   c. Chapter Env-Hw 300 Permits

1.4 PERSONNEL QUALIFICATIONS

A. All personnel of the Contractor or any approved subcontractors involved with asbestos abatement work shall meet the following minimum qualifications:
   1. Medical examination within the past year in accordance with OSHA 1926.134 with a physician's written opinion that the worker has no condition that would preclude him/her from working with asbestos or wearing a respirator.

B. The Contractor shall employ a competent person to oversee all aspects of AC pipe removal.

C. There shall be a sufficient number of trained and qualified workers, foremen and superintendents to accomplish the work within the required schedule. No untrained or unqualified person shall be employed to speed up completion of the abatement work.

1.5 SUBMITTALS

A. Submittals shall be in accordance with Specification Section 01300 - Submittals.

B. At a minimum, the following submittals shall be submitted to the Engineer.
   1. Certification of compliance with OSHA requirements including but not limited to medical surveillance, record keeping and personnel exposure monitoring.
   2. Respiratory Protection Program. Include site specific exposure assessment for respirator selection.
   3. A written project schedule. The schedule shall be date specific and include all phases of the project.
   4. Emergency Action Plan.
   5. Proposed waste disposal site and waste transporter. Include name, address, telephone number and operating permits, etc.
   6. Material safety data sheets (MSDS) for all materials and products to be used by the Contractor on this project.

7. A work plan outlining the methods to be used during the removal of AC pipe. The work plan shall include the use of the Best Management Practices pertaining to the qualifications of field personnel and methods for dust control, packaging, transportation, and decontamination of equipment.

C. During Abatement
   1. Results of personnel exposure monitoring.
   2. Project schedule.

D. Post Abatement Submittals
   1. Disposal receipts (within timeframes regulated by EPA) signed by the landfill operator demonstrating that the AC pipe removed from the project has been packaged, transported and disposed of properly.
   2. Provide the Engineer with copies of on-site job logs, notifications, permits, accident reports, personnel exposure air monitoring results, waivers of lien.
   3. Copies of any notices of non-compliance issued by governmental authorities.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Polyethylene sheeting: shall be at least 6-mil thickness.

B. Disposable bags and/or drums: shall be of 6-mil polyethylene, on which labels are directly printed, as required by EPA, OSHA and DOT regulations.

C. Surfactant (wetting agent): shall be a 50/50 mixture of polyoxyethylene ether and polyoxyethylene ester, or equivalent, mixed in a proportion of 1 fluid ounce to 5 gallons of water or as specified by manufacturer.

PART 3 - EXECUTION

3.1 TOOLS AND EQUIPMENT

A. Transportation Equipment: Transportation equipment, as required, shall be suitable for loading, temporary storage, transport, and unloading of contaminated waste without exposure to persons or property. The equipment shall be secured at all times and access limited to authorized personnel only.

B. The Contractor shall provide approved respirators and protective clothing to all Contractor personnel. The Contractor shall also provide approved protective clothing to representatives of the Owner, and to representatives of the State or other governmental entity who may inspect the job site.

C. Protective clothing requirements must include, but may not be limited to:
   1. One-time use, disposable, full-body coveralls made of Tyvek® fabric or approved equal.
   2. Hard Hats
   3. Eye protection
   4. Gloves
   5. Respiratory protective equipment as required by State law
   6. Other as appropriate for site conditions

D. The Contractor shall have sufficient equipment to mix and spray wetting agents.

E. The Contractor shall have a sufficient quantity of, ladders, hand tools and materials to conduct the abatement project in an efficient and workmanlike manner.

3.2 INSPECTION AND PREPARATION

A. Before any work commences, post danger signs in and around the work area to comply with Federal, State, and local law.

3.3 WORK AREA PREPARATION:

A. Regulated area access is to be restricted to authorized trained/accredited and protected personnel. The Contractor shall control site security during abatement operations in order to isolate work in progress and protect adjacent personnel.
B. Prior to any asbestos related work in an area, restrict access to all persons other than trained personnel and authorized visitors. The Contractor shall erect signs around the perimeter in accordance with EPA, OSHA and this specification. Maintain a log of all people entering and exiting the workplace during abatement work.
C. The Contractor shall be responsible for taking whatever steps are necessary to prevent a release to the environment and additional contamination of the areas beneath the AC pipe.

3.4 AC PIPE CONNECTION AND REMOVAL PROCEDURES

A. Cutting of existing AC pipe shall be minimized. Cutting of AC pipe shall be performed in accordance with all applicable OSHA standards and shall minimize release of AC fibers.
B. AC pipe shall be secured, wrapped, and disposed of in a timely manner. Stockpiling of removed pipe in an unsecured area shall not be allowed.
C. AC pipe shall be transported to a licensed facility for proper disposal.
D. Crushing of pipe in-place shall not be allowed.

3.5 GENERAL PROCEDURES

A. Install polyethylene sheeting beneath the AC pipe to minimize contamination of adjacent soil.
B. All surfaces shall be wetted during removal activities.
C. If AC pipe is found to be friable or will be rendered friable, abatement shall be conducted in containment.
D. AC pipe shall be removed from the trench in an “intact” condition in sizes such that the piping may be handled without breakage.
E. If AC pipe sections can be separated without cutting, the removal may be conducted without containment.
F. Separated non-friable AC pipe sections may be removed without containment.
G. If AC pipe sections require breaking/cutting to separate, all breaking/cutting activities shall be conducted within a glove bag or negative pressure regulated work area (containment).
H. In the event of breakage of AC pipe during removal which results in pieces contacting soil, then the Contractor shall remove all debris and soil located adjacent to and beneath the debris as well as six inches of soil from beneath and surrounding the debris. All resultant debris and soils shall be properly handled, packaged and

disposed of as friable, regulated asbestos waste.

I. The Engineer and Owner shall be notified immediately in the event of breakage.

J. AC pipe shall be double wrapped in 6-mil polyethylene sheeting and labeled prior to transport as required.

3.6 DISPOSAL ACTIVITIES

A. It is the responsibility of the Contractor to determine current waste handling, transportation, and disposal regulations and or requirements for AC pipe and for each waste disposal facility. The Contractor must comply fully with these regulations and all U. S. Department of Transportation and EPA requirements.

B. The Contractor will document actual disposal of the waste at the designated landfill by completing a Waste Shipment Record and forwarding a copy of it along with a copy of the Bill of Lading to the Engineer.

C. All waste load-out and disposal activities shall be the responsibility of the Contractor.

D. Contractor shall insure that transport vehicles do not leak water or other material while being loaded, transported or while on site partially loaded. At minimum, transport vehicles shall be lined with two layers of 6-mil thick polyethylene sheeting installed to form a watertight barrier within the vehicle. If water is observed leaking from any transport or storage container, contractor shall immediately stop work, unload the container (including dumpsters and semi-trailers) find and correct the source of the leak, and place waste material back into the container. This process will be repeated each time any water is observed leaking from a storage or transport vehicle that contains asbestos waste. Contractor shall also take all steps necessary, to decontaminate the ground or other surfaces that became wet due to water leaking from a container that holds asbestos waste.

3.7 CLEANING AND FINAL DECONTAMINATION

A. After the removal of the AC pipe has been completed and before removal of barriers (as applicable), the entire area shall be thoroughly cleaned. All plastic barriers, tapes and disposable contaminated equipment shall also be disposed of as asbestos waste. All reusable contaminated equipment such as masks, hard hats, etc., shall be thoroughly decontaminated through wet cleaning or sealed within 6-mil polyethylene bags before removal from the work area.

END OF SECTION

SECTION 02110

CLEARING AND GRUBBING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:
   1. Clearing and grubbing includes, but is not limited to, removal of trees, brush, stumps, wooded growth, grass, shrubs, poles, posts, signs, fences, culverts and other vegetation and minor structures; the protection of designated wooded growth; the storage and protection of minor structures and materials which are to be replaced; and the disposal of nonsalvageable structures and materials, and necessary preliminary grading.

B. Limits of Work:
   1. Perform clearing and grubbing work within the areas required for construction, or as shown on the Drawings, to a depth of l2 inches below the existing grade.
   2. Perform additional clearing and grubbing work within areas and to depths which, in the opinion of the Engineer, interfere with excavation and/or construction, or are otherwise objectionable.

C. Work Not Included:
   1. Clearing and grubbing work performed for the convenience of the Contractor will not be considered for payment.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:
   1. Dispose of combustible material by burning only when permitted by and in accordance with all applicable local and state laws, ordinances and code requirements.

B. Remove and dispose of nonsalvageable structures and material in accordance with all applicable local and state laws, ordinances and code requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide all materials required to complete the work.

B. All timber and wood shall become the property of the Contractor unless other agreements are made between the Owner and the Contractor.

C. Repair any damage to structures to the complete satisfaction of the Owner and Engineer

PART 3 - EXECUTION

3.1 PREPARATION

A. Carefully preserve and protect from injury all trees and/or shrubs not to be removed.

B. Right-of-way:

1. Where excavation is required on public or private rights-of-way containing trees, shrubs, other growth, or any structure or construction, obtain the Engineer's direction concerning the extent to which such obstacles can be cleared or stripped prior to performing the Work.
2. In all rights-of-way, remove only those particular growths or structures which are, in the opinion of the Engineer, essential for construction operations.
3. All other removals or damage shall be replaced or restored at the Contractor's expense.

3.2 PERFORMANCE

A. Clearing:

1. Remove and dispose of all trees, brush, slash, stubs, bushes, shrubs, plants, debris and obstructions within the area to be cleared, except any areas that may be designated as "Selective Clearing", and except as otherwise shown on the Drawings or as directed by the Engineer.
2. Remove all stumps unless otherwise directed by the Engineer.
3. Dispose of material to be removed daily as it accumulates.
4. Take special care to completely dispose of all elm trees and branches immediately after cutting either by burial in approved locations or, when permitted, by burning in areas well removed from standing elm growth.

B. Protection of Wooded Growth:

1. Fell trees toward the center of the area being cleared to protect trees and shrubs to be left standing.
2. Cut up, remove and dispose of trees unavoidably falling outside the area to be cleared.
3. Employ skilled workmen or tree surgeons to trim and repair all trees that are damaged but are to be left standing.

C. Selective Clearing:

1. When shown on the Drawings and when directed by the Engineer, perform selective clearing work to preserve natural tree cover.
2. Perform selective clearing work only under the direction and supervision of the Engineer.
3. Remove all dead and uprooted trees, brush, roots and other material which, in the opinion of the Engineer, are objectionable.
4. Cut flush with the ground and remove only those trees indicated by the Engineer.
5. Employ skilled workmen or tree surgeons to carefully trim all branches requiring cutting on trees to be left standing. Wood exposed as the result of removal of branches is to be left exposed to air and sunlight.
6. Bituminous paint shall not be used on wood exposed as a result of branch removal, excavation around roots, or damage to tree bark.

D. Grubbing:
   1. Perform grubbing work beneath new roads, driveways, walks, seeded areas and other areas and as directed by the Engineer.
   2. Grub out all sod, vegetation and other objectionable material to a minimum depth of l2 inches below the existing grade.
   3. Completely remove all stumps, including major root systems.

E. Disposal:
   1. Remove from the site and dispose of material not being burned.
   2. Provide an approved disposal area unless otherwise specified.

F. Burning:
   1. Dispose of combustible materials by burning, only if approved by local and state officials.
   2. Employ competent workmen to perform burning work in such a manner and at such locations that adjacent properties, trees and growth to remain, overhead cables, wires and utilities will not be jeopardized.
   3. Do not leave fires unguarded.
   4. Do not burn poison oak, poison ivy or other plants of similar nature.
   5. Do not use tires or other combustible waste material to augment burning.
   6. Burn combustible materials daily as the work progresses.
   7. The Contractor shall be responsible for all damage caused by burning and shall be responsible for obtaining all necessary permits for burning.

3.3 REPLACEMENT OF MATERIALS

A. Paving, Curbing and Miscellaneous Material:
   1. Remove all paving, subpaving, curbing, gutters, brick, paving block, granite curbing, flagging and minor structures that are over the area to be filled or excavated.
   2. Remove and replace bituminous asphaltic and portland cement concrete in accordance with the appropriate sections of these Specifications.
   3. Properly store and preserve all material to be replaced in a location approved by the Engineer.

B. Shrubs and Bushes:
   1. Remove, store, and replace ornamental shrubs and bushes to be preserved in accordance with accepted horticultural practices.

C. Topsoil:
   1. When applicable, carefully remove, store, and protect topsoil in accordance with the appropriate section of this division.

D. Responsibility:
   1. Replace, at no additional cost to the Owner, materials lost or damaged because of careless removal or neglectful or wasteful storage, disposal or use of these materials.

END OF SECTION

SECTION 02140

TEMPORARY CONSTRUCTION DEWATERING SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:
   1. Design, furnish, operate, maintain, and remove temporary dewatering system to lower and control ground water table levels and hydrostatic pressures to permit excavation, backfill, and construction to be performed in the dry; collect and dispose of ground and surface water where necessary to complete the work.
   2. Design, furnish, operate, maintain, and remove temporary treatment system for temporary dewatering system effluent prior to discharge to ground or storm water catch basin if available. Conduct compliance testing, in accordance with the requirements of the permitting authority.

B. Related Work Specified Elsewhere: (When Applicable)
   1. Section 02156 Temporary Excavation Support System
   2. Section 02200 Earthwork
   3. Geotechnical Data Report is provided in Appendix A.

1.2 DESIGN REQUIREMENTS

A. Dewatering system shall be designed by a Professional Engineer registered in the State of New Hampshire who is experienced in the design of Dewatering systems. Engineer shall at least 5 years of experience designing similar temporary dewatering systems.

B. Dewatering system shall be of sufficient size and capacity necessary to lower and maintain ground water table to an elevation at least two feet below the lowest foundation subgrade or bottom of pipe trench to allow material to be excavated in a dry condition. Materials to be removed shall be sufficiently dry to permit excavation to grades shown and to stabilize excavation slopes where temporary excavation support systems are not required. Operate dewatering system continuously until backfill work has been completed.

C. Control of surface and subsurface water is part of dewatering system requirements. Maintain adequate control so that:
   1. The stability of excavated and constructed slopes are not adversely affected by saturated soil, including water entering prepared subbase and subgrades where underlying materials are not free draining or are subject to swelling or freeze-thaw action.
   2. Erosion is controlled.
   3. Flooding of excavations or damage to structures does not occur.
   4. Surface water drains away from excavations.
   5. Excavations are protected from becoming wet from surface water, or ensure excavations are dry before additional work is undertaken
   6. Prevent loss of fines, seepage, boils, quick conditions or softening of foundation strata.

7. Maintain stability of sides and bottom of excavation. Construction operations are performed in the dry.
8. Any existing dewatering wells that can affect dewatering and excavation shall be sealed below the excavation subgrade.

D. Design shall include an assessment of how the dewatering operations will affect the stability of all adjacent structures

E. Contractor is responsible to perform whatever additional geotechnical investigations needed to design the dewatering system to allow for proper construction of new facilities while protecting adjacent structures from damage due to settlement, and in accordance with this specification. The geotechnical engineering report prepared for the City of Portsmouth by S.W. Cole Engineering, Inc, dated August 19, 2020 is for information only. The data provided in the report is obtained for the purposes of design of the structures shown on the drawings and is not intended to meet all the needs of the contractor during construction.

1.3 SUBMITTALS

A. Provide submittals in accordance with Specification Section 01340.

B. Submit qualifications of temporary dewatering system design engineer.

C. Submit design calculations, description and complete scaled and dimensioned layout drawings of the proposed dewatering system, stamped and sealed by a Professional Engineer registered in the State of New Hampshire. Such review shall not relieve the Contractor of sole responsibility for the dewatering system as necessary to prevent damage and settlement to adjacent structures, utilities, streets adjacent to excavations and for the safety of persons working within the excavated areas. Submittal shall identify:

1. Location, depth and size of wellpoints, headers, sumps, ditches; size and location of discharge lines; capacities of pumps and standby units, and detailed description of dewatering methods to be employed to convey the water from site to adequate disposal.
2. Estimated average, minimum and maximum pumping rates (total)
3. Method to minimize or eliminate pumping of fines.
4. Standby pumping equipment
5. Standby power equipment
6. Treatment tankage and discharge locations
7. Sample monitoring log (flow, TSS, etc.).
8. System removal requirements.
9. Written approval from the Owner for disposal of the treated water.

D. Submittals under this Section shall be provided concurrently with and coordinated with the submittals under Section 02156 (Temporary Excavation Support Systems).

E. Submit monitoring results at the frequency required by the permitting authority.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.1 PERFORMANCE

A. General:
   1. Prior to any excavation below the ground water table, place system into operation to lower water table as required and operate it continuously 24 hours a day, 7 days a week until utilities and structures have been satisfactorily constructed, which includes the placement of backfill materials and dewatering is no longer required.
   2. Keep work areas dewatered until the structures, pipes, and appurtenances to be built there have been completed to such an extent that they will not be damaged by water.
   3. Thoroughly brace or otherwise protect against flotation all pipelines and structures which are not stable.
   4. Maintain standby backup equipment and power supply throughout the duration of the dewatering operation.
   5. Prevent soil particles from entering the discharge points.
   6. Ground water level shall be maintained at least two feet below the bottom of the excavation.

B. Disposal of Water:
   1. Dispose of water pumped or drained from the construction site in a suitable manner to avoid siltation of adjacent drainage structures and piping, wetlands or water bodies, injury to public health, damage to public and private property, and damage to the work completed or in progress.
   2. Provide suitable temporary channels for water that may flow along or across the construction site.
   3. Provide treatment as necessary to prevent discharge of contaminated ground water caused by Contractor's operations, or any contaminated ground water that may pass through the excavation support system selected by the Contractor.
   4. Contractor must obtain all necessary regulatory approvals for the disposal of dewatering flows. These may include, among others, approval by the USEPA under the National Pollutant Discharge Elimination System (NPDES) program for construction activities.

C. Damage:
   1. Avoid damage to and settlement of adjacent buildings, roads, structures, utilities and other facilities.
   2. Any damage to or settlement of structures resulting from the dewatering operations, or the failure of the Contractor to maintain the work in a suitably dry condition shall be repaired by the Contractor at no additional cost to the Owner.

D. Temporary Underdrains:
   1. When necessary, temporary underdrains may be placed in excavations.
   2. Underdrain pipe shall be perforated corrugated metal, polyethylene or P.V.C. pipe.
   3. Entirely surround the underdrain and fill the space between the underdrain and the pipe or structure with free draining material.

E. Excavation Sump Pumping:
   1. When necessary and where appropriate to the geotechnical conditions encountered, excavations may be over excavated 6 to 12 inches and filled with screened stone to allow sump pumping of groundwater.
   2. The system shall be installed with suitable screens and filters so that pumping of fines does not occur.

F. Well and Wellpoint System:
   1. If necessary, dewater the excavations and trenches with an efficient well or wellpoint system to drain the soil and prevent saturated soil from flowing into the excavated wells and area.
   2. Wellpoint and well system shall be of the type designed for dewatering work and shall be installed with suitable screens and filters so that pumping of fines does not occur.
   3. Pumping units shall be capable of maintaining sufficient suction to handle large volumes of air and water at the same time.

3.2 PRE-TREATMENT

A. Contractor shall provide a settling tank (or tanks) to provide pre-treatment of groundwater prior to discharge. Tanks shall be sized to provide 60-minute hydraulic retention time at the anticipated maximum sustained pumping rate. Tanks shall have an underflow baffle to collect any floatables and shall have final overflow weir to allow for flow measurement and sample collection. The effluent weir shall be sized to allow for accurate flow measurement based on the anticipated pumping rates.

B. Routine inspection of the settling tanks shall be carried out daily, with records maintained.

C. Settling tanks shall be cleaned frequently to prevent excess deposition of solids which could overflow from the tank.

D. Conduct effluent sampling requirements per the requirements of the permitting authority which is receiving the pre-treated dewatering system effluent.

3.3 MONITORING

A. General:
   1. Contractor shall monitor the performance of the dewatering system and the groundwater level achieved throughout construction.
   2. Contractor shall monitor the effluent quality from the treatment system as required by the permitting authority.

B. Corrective Action:
   1. If dewatering requirements are not satisfied due to inadequacy or failure of the dewatering system (loosening of the foundation strata, or instability of slopes, or damage to foundations or structures), the Contractor shall stop work and submit a revised temporary dewatering system design submittal. The revised plan shall indicate why the system revisions are needed and indicated what change will be made to address the issues. Contractor shall perform work necessary for reinstatement of foundation soil and damaged structure resulting from such inadequacy or failure by Contractor, at no additional cost to Owner.

CERTIFICATE OF DESIGN

RE: Contract between
OWNER: _____
(Name)
and
CONTRACTOR: _____
(Name)
on
CONTRACT: _____
(Title)
_____
(Number) (Date)

The undersigned hereby certify that the engineer listed below:

1. Is licensed or registered to perform professional engineering work in the state of _____ (location of Project);

2. Is qualified by education and training to design the _____ _____ specified in Section _____ of subject contract;

3. Has previously designed comparable groundwater dewatering systems;

4. Has prepared the design in full compliance with the requirements of subject contract, including all applicable laws, regulations, rules, and codes – including review and coordination with the Temporary Excavation Support System design; and

5. Will inspect and supervise installation of the temporary dewatering system and will monitor the in-place system to confirm that the system is installed and functions in accordance with the design.

CONTRACTOR	ENGINEER
By: _____ (Signature)	By: _____ (Signature)
_____ (Name)	_____ (Name)
_____ (Title)	_____ (Engineering Discipline)
_____ (Date)	_____ (Date)

END OF SECTION

SECTION 02156

TEMPORARY EXCAVATION SUPPORT SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Design, furnish, install, maintain, and remove temporary excavation support system as required to comply with all applicable State and Federal regulations including the Occupational Safety and Health Act. Excavation support system shall consist of steel sheeting, pile and lagging bracing or other systems designed by the Contractor. Related Work Specified Elsewhere (When Applicable):
   1. Section 02140 Temporary Construction Dewatering System
   2. Section 02200 Earthwork
   3. Geotechnical Data Report is provided in Appendix A.

1.2 DESIGN REQUIREMENTS

A. The Contractor shall be responsible for the design and construction of the excavation support structures. The excavation support structures (sheeting systems or other special excavation techniques) shall be properly designed by a Professional Engineer registered in the State of New Hampshire, who practices in a discipline applicable to excavation work and has more than 5 years of experience in the design of excavation support systems. The excavation support system shall be designed to accommodate an additional 2 feet of excavation below the bottom of excavation shown on the Contract Drawings.

B. The excavation support system shall be designed and installed to limit the upward hydraulic gradient into the bottom of the excavation and to sustain all existing and expected loads and utilities, to prevent migration of fine-grained materials into the excavation, to prevent all movement to earth which could in any way cause injury to workmen, delay the work or endanger adjacent structures. If detrimental effects result from construction activities, the Contractor shall modify the design, revise construction procedures and/or take measures to mitigate and abate further movement at no cost to the Owner.

C. The Contractor shall prepare an excavation support system monitoring plan intended to monitor the performance of the excavation support system, as well as the adjacent grade and adjacent structures, throughout construction. The excavation support system monitoring plan shall include vibration and deformation monitoring. Contractor shall retain the services of a qualified vibration monitoring consultant to perform vibration monitoring during installation and removal of the excavation support system. Refer to Paragraphs 1.3 and 3.4 for additional requirements.

D. The internal lateral bracing shall be located so that the braces shall not pass-through walls and/or slabs of existing or proposed structures.

E. The support system shall provide adequate room to properly perform the installation and to allow for inspection of the installation.

F. Prior to the installation of any portion of the temporary lateral support system, the Contractor shall furnish to the Owner precondition surveys documenting the existing conditions of the adjacent structures.

G. The use of existing structures to support the sheeting bracing or structural framing shall be prohibited.

1.3 SUBMITTALS

A. Provide submittals in accordance with Specification Section 01340.

B. Submit qualifications of temporary excavation support system design engineer.

C. Submit attached certificate of design and complete scaled and dimensioned layout drawings of the proposed excavation system, stamped and sealed by a Professional Engineer registered in the State in which the project is located. Drawings shall show plan, sections and elevations of the support system as well as the proposed structures. Submittal shall identify:

1. Physical location on the site and identify any existing utilities, site piping, site electrical conduit that must be relocated prior to excavation support system installation.
2. Type and location of any surcharge loads adjacent to the excavation support system required by the Contractor to execute the work (e.g., excavators, trucks, cranes, soil piles, etc.).
3. Design calculations, supporting documentation and materials cut sheets.
4. Sample monitoring log.
5. System removal requirements.

D. Submit excavation support system monitoring plan, including qualifications of Contractor's vibration monitoring consultant and Contractor's surveyor. The excavation support system monitoring plan shall identify: the specific method, location and frequency of measurements (pre-, during and post-construction); individual(s) responsible for inspection/measurements; submittal and maintenance of on-site records; and threshold vibration values and excavation support system deformation values that, if exceeded, will require immediate stoppage of work and the performance of repairs necessary for reinstatement of a functional system. Provide justification for recommended vibration and deformation tolerances, on a structure-by-structure basis.

E. The Contractor shall have sole responsibility for design, construction, monitoring and removal of the excavation support system as necessary to prevent damage to adjacent structures, utilities, streets adjacent to excavations and for safety of persons working within the excavated areas. The submittals will be reviewed for consistency with the design intent.

F. Submittals under this Section shall be provided concurrently with and coordinated with the submittals under Section 02401 (Temporary Dewatering System).

PART 2 - PRODUCTS

2.1 MATERIAL

A. All materials shall conform to all applicable State and Federal regulations including the Occupational Safety and Health Act.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Perform preparatory work to discover, protect, maintain and restore utilities, foundations or other facilities located in close proximity of the proposed excavation lateral support system.

B. Conduct pre-excavation to remove obstructions along the alignment of the excavation lateral support system which will interfere with installation of the excavation lateral support system.

C. Install the excavation support system, including the installed wall and bracing system, outside the limits of the permanent structure. Construction tolerances (e.g., wall verticality) and lateral wall deflections as a result of excavation and other activities shall be considered in determining the plan location.

D. Excavation shall not proceed more than 2 ft. below the bracing level, anywhere within the excavation support limits, until the entire level of bracing is completely installed.

E. The first level of bracing shall be installed within 5 ft. of the ground surface prior to any excavation below this level.

3.2 INSTALLATION

A. Install excavation support system in accordance with all applicable State and Federal regulations including the Occupational Safety and Health Act. The excavation support system design engineer shall visit the site during excavation support system installation.

3.3 INTERNAL LATERAL WALL BRACING (RAKERS, WALES AND STRUTS)

A. Rakers are only allowed for the temporary lateral brace that is installed within 5 ft. of the ground surface. Contractor shall coordinate the location of all rakers on plan with surrounding utilities and submit to the engineer for approval prior to installation.

B. Use wales, struts, corner braces to provide support of the excavation lateral support walls as required. Include web stiffeners, plates, brackets, or angles as required to prevent rotation, crippling or buckling of connections and points of bearing between structural steel members. Allow for eccentricities due to fabrication and assembly. Consider effects of temperature changes.

C. Install and maintain all support members in continuous tight contact with each other and with the wall being supported.

D. Preload all bracing members (including rakers, corner braces, and struts) in accordance with methods, procedures and sequence as described on the reviewed shop drawings. Coordinate excavation work with installation of bracing and preloading. Use steel shims and steel wedges, welded or bolted in place, to maintain the preloading force in the bracing after release of the jacking equipment pressure. Wood shims or wedges shall not be used. Braces shall be preloaded to 50 percent of the maximum design load. Provide means to control the fluctuation of loading due to temperature variations.

E. Accomplish preloading by jacking struts, rakers, etc. in place against the excavation lateral support system walls, or by other methods acceptable to the Owner or Owner's Representative.

3.4 MONITORING

A. Contractor shall implement the excavation support system monitoring plan intended to monitor the performance of the excavation support system, as well as adjacent grade and adjacent structures, throughout construction. Monitoring shall include the following at a minimum:
   1. Pre-Installation Structure Elevation Survey. Survey prior to excavation support system installation.
   2. Vibration Monitoring. Full-time vibration monitoring during excavation support system installation.
   3. Installation Structure and Support System Surveys.
      a. After excavation support system installation but prior to first brace installation;
      b. When at mid-point of excavation;
      c. When at bottom of excavation;
      d. At weekly intervals during structure construction.
      e. Prior to excavation support system removal.
      f. Each survey shall assess the support system deformation and key structures.
   4. Vibration monitoring. Full-time during excavation support system removal.
   5. Post-Installation Structure Survey. Survey after removal of excavation support system.

B. The excavation support system design engineer shall visit the site during the monitoring program at periodic intervals.

C. Additionally, if the excavation support system monitoring criteria/requirements are not satisfied due to inadequacy or failure of the excavation support system (settlement of adjacent grade, settlement of structures, cracking of structures, etc.), immediately stop work and perform repairs necessary for reinstatement of a functional system, as well as restoration of foundation soil and damaged structure resulting from such inadequacy or failure by Contractor, at no additional cost to Owner.

3.5 REMOVAL OF SHEETING

A. Remove all sheeting and bracing unless the removal may cause injury to adjacent structures and/or property.

B. The General Contractor shall be responsible for repairing all damage to existing structures caused by the removal of sheeting. The excavation support system design engineer shall visit the site during excavation support system removal.

C. All backfill disturbed by the removal of the sheeting shall be re-compacted to its in-situ density.

D. Proceed with backfilling as specified in these Specifications. When the level of compacted backfill reaches the location of bracing and wales, remove these items from the trench or other excavation. When the level of the backfill reaches a point three feet below the existing ground grade, remove the sheeting by approved methods and equipment.

E. After removing the sheeting, complete backfilling in the usual manner.

F. If the Contractor elects to leave the sheeting or any component of the temporary support system in place, the Contractor shall cut the sheeting or such component at least 4 feet below the ground surface, or as directed by the Engineer.

CERTIFICATE OF DESIGN

RE: Contract between
OWNER: _____
(Name)
and
CONTRACTOR: _____
(Name)
on
CONTRACT: _____
(Title)
_____
(Number) (Date)

The undersigned hereby certify that the engineer listed below:

1. Is licensed or registered to perform professional engineering work in the state of _____(location of Project);

2. Is qualified by education and training to design the _____ _____ specified in Section _____ of subject contract;

3. Has previously designed comparable excavation support systems;

4. Has prepared the design in full compliance with the requirements of subject contract, including all applicable laws, regulations, rules, and codes – including review and coordination with the Dewatering System design; and

5. Will inspect and supervise installation of the excavation support system, will monitor the in-place system to confirm that the system is installed and functions in accordance with the design and will inspect and supervise the removal of the excavation support system.

CONTRACTOR	ENGINEER
By: _____ (Signature)	By: _____ (Signature)
_____ (Name)	_____ (Name)
_____ (Title)	_____ (Engineering Discipline)
_____ (Date)	_____ (Date)

END OF SECTION

SECTION 02200

EARTHWORK

PART 1 - GENERAL

1.1 DESCRIPTION

A. The Work described by this Section consists of all earthwork encountered and necessary for construction of the project as indicated in the Contract Documents, and includes but is not limited to the following:
   1. Excavation
   2. Backfilling and Filling
   3. Compaction
   4. Embankment Construction
   5. Grading
   6. Providing soil material as necessary
   7. Disposal of unsuitable materials
   8. Disposal of excess suitable material

B. Related Work Specified Elsewhere: (When Applicable)
   1. Traffic Regulation is specified in Division 1.
   2. Clearing and Grubbing, Dewatering, Filter Fabric, Temporary Erosion Control, Stripping and Stockpiling of Topsoil, Sheeting, Landscaping, and Paving are specified in the appropriate sections of this Division.
   3. Section 01400 - Quality Control.
   4. Pipe, fittings and valves are specified in 2.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:
   1. All work shall be performed and completed in accordance with all local, state and federal regulations.
   2. The General Contractor shall secure all other necessary permits unless otherwise indicated from, and furnish proof of acceptance by, the municipal and state departments having jurisdiction and shall pay for all such permits, except as specifically stated elsewhere in the Contract Documents.

B. Line and Grade:
   1. The Contractor shall establish the lines and grades in conformity with the Drawings and maintain same to properly perform the work.

C. Testing Methods:
   1. Gradation Analysis: Where a gradation is specified the testing shall be in accordance with ASTM C-117-90 and ASTM C-136-93 (or latest revision).

2. Compaction Control:
   a. Unless otherwise indicated, wherever a percentage of compaction for backfill is indicated or specified, it shall be the in-place density divided by the maximum density and multiplied by 100. The maximum density shall be the density at optimum moisture as determined by ASTM Standard Methods of Test for Moisture-Density Relations of Soil Using 10-lb. Hammer and 18-in. Drop, Designation D-1557-91 (Modified Proctor), or latest revision, unless otherwise indicated.
   b. The in-place density shall be determined in accordance with ASTM Standard Method of Test for Density of Soil in Place by the Sand Cone method, Designation D 1556-90, (or latest revision) or Nuclear method Designation D6938.
   c. Wherever specifically indicated, maximum density at optimum moisture may be determined by ASTM Standard Methods of Test for Moisture Density Relations of Soils, ASTM D-698-91 (Standard Proctor).
   d. An Independent Testing Laboratory will be retained by the Owner to conduct all laboratory and field soil sampling and testing, and to observe earth work and foundation construction activities. Laboratory testing will consist of sieve analyses, natural water content determinations, and compaction tests. Field testing will consist of in-place field density tests and determination of water contents.

1.3 SUBMITTALS

A. Collection of samples and testing of all materials for submittals shall be performed by the Independent Testing Laboratory and paid for by the Contractor until the materials are approved by the Owner or Engineer.
B. Submit test results in accordance with the procedure specified in the General and Supplementary Conditions.
C. Submit test results (including gradation analysis) and source location for all borrow material to be used at least 10 working days prior to its use on the site. Contractor shall identify and provide access to borrow sites.
D. Submit moisture density curve for each type of soil (on site or borrow material) to be used for embankment construction or fill beneath structures or pavement.

1.4 TESTS

The Independent Testing Laboratory shall conform to the following procedures and standards:

A. Submit test results in accordance with the procedure specified in the General and Supplementary Conditions.
B. All testing shall be performed by a qualified Independent Testing Laboratory acceptable to the Engineer and Contractor at the Owner's expense unless otherwise indicated (see Section 01400 - Quality Control).
C. Field density tests on embankment materials shall be as follows:
D. Tests shall be taken on every 200 cubic yards of embankment material.

E. Paved Areas and Building Slab Subgrade: Make at least one field density test of subgrade for every 2,000 sq. ft. of paved area or building slab, but in no case less than 3 tests. In each compacted fill layer, make one field density test for every 2,000 sq. ft. of overlaying building slab or paved area, but in no case less than 3 tests.

F. Trenches: Field density test in trenches shall be taken at 75 linear foot intervals on every third lift.

G. Foundation Wall Backfill: Take at least one (1) field density tests per lift per wall at locations and elevations as designated by the Engineer.

H. In addition to the above tests the Independent Testing Laboratory will perform additional density tests at locations and times requested by the Engineer.

I. Additional density testing will be required by the Engineer if the Engineer is not satisfied with the apparent results of the Contractor's compaction operation.

1. If the test results fail to meet the requirements of these specifications, the Contractor shall undertake whatever action is necessary, at no additional cost to the Owner, to obtain the required compaction. The cost of retesting will be paid by Owner. The cost of retesting will be determined by Engineer and Owner will invoice Contractor for this cost. If unpaid after 60 days, the invoice amount for retesting will be deducted from the Contract Price. No allowance will be considered for delays in the performance of the work.
2. If the test results pass and meet the requirements of these Specifications, the cost of the testing service will be borne by the Owner, but no allowance will be considered for delays in the performance of the work.

1.5 JOB CONDITIONS

A. Site Information:

1. Data on indicated subsurface conditions are not intended as representations or warranties of accuracy or continuity between soil borings. It is expressly understood that Owner and Engineer will not be responsible for interpretations or conclusions drawn there from by the Contractor. Data are made available for the convenience of Contractor.
2. Additional test borings and other exploratory operations may be made by Contractor at no additional cost to Owner.

B. Existing Utilities and Structures:

1. The locations of utilities and structures shown on the Drawings are approximate as determined from physical evidence on or above the surface of the ground and from information supplied by the utilities. The Engineer in no way warranties that these locations are correct. It shall be the responsibility of the Contractor to determine the actual locations of any utilities or structures within the project area.

PART 2 - PRODUCTS

2.1 SOIL MATERIAL

A. Aggregate Base: Shall be screened or crushed gravel of hard durable particles free from vegetable matter, lumps or balls of clay and other deleterious substances. Type B Aggregate for base shall not contain particles of rock that will not pass the 4 inch square mesh sieve. The gradation of the part that passes a 3-inch sieve shall meet the following grading requirements:

Sieve Designation	Percent by Weight Passing Square Mesh Sieves Type B Aggregate
3 inch	100
2 inch	95-100
1 inch	55-85
No. 4	27-52

B. Common Borrow: Shall consist of approved material required for the construction of the work where designated. Common borrow shall be free from frozen material, perishable rubbish, peat, organic, and other unsuitable material.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
6-inch	100
No. 200	0-5

Common borrow may be used for embankments unless otherwise indicated and provided that the material is at a moisture content suitable for compaction to the specified density. No rocks shall exceed 3/4 of the depth of the specified lift thickness.

C. Crushed Stone: Shall be a uniform material consisting of clean, hard, and durable particles or fragments, free from vegetable or other objectionable matter, containing angular pieces, as are those which come from a mechanical crusher. Shall meet the requirements of NHDOT 304.4 crushed stone. Gradation requirements shall be as follows:

Sieve Designation	Percent by Weight Passing Square Mesh Sieve
2 inch	100
1-1/2 inch	85-100
3/4 inch	45-75
No. 4	10-45
No. 200	0-10

D. Screened Stone: Shall be a well graded stone consisting of clean, hard, and durable particles or fragments, free from vegetable or other objectionable matter, meeting the following gradation requirements:

Sieve Designation	Percent by Weight Passing Square Mesh Sieve
1 inch	100
3/4 inch	90-100
3/8 inch	20-55
No. 4	0-10
No. 8	0-5

E. Select Fill (Structural Fill): Shall consist of well graded granular material free of organic material, loam, wood, trash, snow, ice, frozen soil and other objectionable material and having no rocks with a maximum dimension of over 4 inches and meeting the following gradation requirements, except where it is used for pipe bedding in which case the maximum size shall be 2 inches.

Sieve Designation	Percent by Weight Passing Square Mesh Sieve
4 inch	100
3 inch	90-100
¼ inch	25-90
No. 40	0-30
No. 200	0-6

F. Sand: Shall be well graded durable material free of organic matter and conform to the following gradation requirements:

Sieve Designation	Percent by Weight Passing Square Mesh Sieve
3/8 inch	100
No. 4	95-100
No. 16	50-85
No. 50	10-30
No.100	2-10
No.200	0-5

Sand conforming to the requirement for fine aggregate in ASTM Standard Specifications for Concrete Aggregate, Designation C-33, will meet the above requirement.

2.2 CONCRETE

A. If concrete is required for excess excavation, provide 3,000 psi concrete complying with requirements of Section 03300.

2.3 FILTER FABRIC

A. If filter fabric is required, refer to Section 02260.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions under which excavating, backfilling, filling, compaction and grading are to be performed and notify the Engineer in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 EXCAVATION

A. General:
   1. Excavation consists of removal and disposal of all material encountered when establishing line and grade elevations required for execution of the work.
   2. The Contractor shall make excavations in such manner and to such widths as will give suitable room for building the structures or laying and jointing the piping; shall furnish and place all sheeting, bracing, and supports; shall do all cofferdamming, pumping, and draining; and shall render the bottom of the excavations firm, dry and acceptable in all respects.
   3. All excavation shall be classified as either earth or ledge.
      a. Earth Excavation shall consist of the removal, hauling and disposal of all earth materials encountered during excavation including but not limited to native soil or fill, pavement (bituminous or concrete), existing sewers and manholes, ashes, loam, clay, swamp muck, debris, soft or disintegrated rock or hard pan which can be removed with a backhoe, or a combination of such materials, and boulders that do not meet the definition of "Ledge" below.
      b. Ledge Excavation: Shall consist of the removal, hauling, and disposal of all ledge or rock encountered during excavation. "Ledge" and "rock" shall be defined as any natural compound, natural mixture that in the opinion of the Engineer can be removed from its existing position and state only by drilling and blasting, wedging, sledging, boring or breaking up with power operated tools. No boulder, ledge, slab, or other single piece of excavated material less than two cubic yards in total volume shall be considered to be rock unless, in the opinion of the Engineer it must be removed from its existing position by one of the methods mentioned above.

4. The Contractor shall not have any right of property in any materials taken from any excavation. Do not remove any such materials from the construction site without the approval of the Engineer. This provision shall in no way relieve the Contractor of his obligations to remove and dispose of any material determined by the Engineer to be unsuitable for backfilling. The Contractor shall dispose of unsuitable and excess material in accordance with the applicable sections of the Contract Documents.

B. Additional Excavation: When excavation has reached required subgrade elevations, notify the Engineer and Resident Project Representative who will observe the conditions.
   1. If material unsuitable for the structure or paved area or pipeline (in the opinion of the Engineer) is found at or below the grade to which excavation would normally be carried in accordance with the Drawings and/or Specifications, the Contractor shall remove such material to the required width and depth and replace it with thoroughly compacted select fill, screened stone, crushed stone, or concrete as directed by the Engineer.
   2. All excavated materials designated by the Engineer as unsuitable shall become the property of the Contractor and disposed of at locations in accordance with all State and local laws and the provisions of the Contract Documents.

C. Unauthorized Excavation: Shall consist of removal of materials beyond indicated subgrade elevations or dimensions without specific authorization of Engineer. Unauthorized excavation, as well as remedial work required by the Engineer shall be at the Contractor's expense. Remedial work required is as follows:
   1. Under footings, foundation bases, or retaining walls, fill unauthorized excavation with select fill or screened stone compacted to 95%. Provide 12" minimum select fill or screened stone directly under footings. Concrete fill may be used to bring elevations to proper position, when acceptable to Engineer.
   2. If the bottom of a trench is excavated beyond the limits indicated, backfill the resulting void with thoroughly compacted screened stone, unless otherwise indicated.
   3. Elsewhere, backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by Engineer.

D. Structural Excavation:
   1. Shall consist of the removal, hauling, disposal, of all material encountered in the excavation to permit proper installation of structures.
   2. Excavations for structures shall be carried to the lines and subgrades shown on the Drawings.
   3. Excavate areas large enough to provide suitable room for building the structures.
   4. The extent of open excavation shall be controlled by prevailing conditions subject to any limits designated by the Engineer.

5. Provide, install, and maintain sheeting and bracing as necessary to support the sides of the excavation and to prevent any movement of earth which could diminish the width of the excavation or otherwise injure the work, adjacent structures, or persons and property in accordance with all state and OSHA safety standards.
6. Erect suitable fences around structure excavation and other dangerous locations created by the work, at no additional cost to the Owner.
7. Exposed subgrade surfaces shall remain undisturbed, protected, and maintained as uniform, plane areas and shape to receive the foundation components of the structure.
    a. Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10', and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.
    b. In excavating for footings and foundations, take care not to disturb bottom of excavation. Excavate by hand to final grade and trim bottoms to required lines and grades to leave solid base to receive the structure.
    c. If a structure is to be constructed within the embankment, the fill shall first be brought to a minimum of 3 feet above the base of the footing. A suitable excavation shall then be made as though the fill were undisturbed earth.

E. Trench Excavation: Shall consist of removal, hauling and disposal of all material encountered in the excavation to the widths and depths shown on the Drawings to permit proper installation of underground utilities.
1. Excavate trenches to the uniform width shown on the Drawings sufficiently wide to provide sufficient space for installation, backfilling, and compaction. Every effort should be made to keep the sides of the trenches firm and undisturbed until backfilling has been completed and consolidated.
2. Trenches shall be excavated with approximately vertical sides between the elevation of the center of the pipe and an elevation one foot above the top of the pipe.
3. Grade bottoms of trenches as indicated for pipe and bedding to establish the indicated slopes and invert elevations, notching under pipe joints to provide solid bearing for the entire body of the pipe, where applicable.
4. If pipe is to be laid in embankments or other recently filled material, the material shall first be placed to the top of the fill or to a height of at least two feet above the top of the pipe, whichever is the lesser. Particular care shall be taken to ensure maximum consolidation of material under the pipe location. The pipe trench shall be excavated as though in undisturbed material.
5. Unless otherwise specifically directed or permitted by the Engineer, begin excavation at the low end of sewer and storm lines and proceed upgrade.
6. Perform excavation for force mains and water mains in a logical sequence.

7. The extent of open excavation shall be controlled by prevailing conditions subject to any limits prescribed by the Engineer.
8. As the excavation progresses, install such shoring and bracing necessary to prevent caving and sliding and to meet the requirements of the state and OSHA safety standards, as outlined in the appropriate section of this Specification.

F. Protection of Persons, Property and Utilities:
1. Barricade open excavations occurring as part of this work and post with warning lights in compliance with local and State regulations.
2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations. Exercise extreme caution and utilize sheeting, bracing, and whatever other precautionary measures that may be required.
3. Rules and regulations governing the respective utilities shall be observed in execution of all work. Active utilities and structures shall be adequately protected from damage, and removed or relocated only as indicated or specified. Inactive and abandoned utilities encountered in excavation and grading operations shall be removed, plugged or capped only with written authorization of the utility owner. Report in writing to the Engineer, the locations of such abandoned utilities. Extreme care shall be taken when performing work in the vicinity of existing utility lines, utilizing hand excavation in such areas, as far as practicable.
4. Repair, or have repaired, all damage to existing utilities, structures, lawns, other public and private property which results from construction operations, at no additional expense to the Owner, to the complete satisfaction of the Engineer, the utility, the property owner, and the Owner.

G. Stability of Excavations:
1. Slope sides of excavations to comply with all codes and ordinances having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.
2. Maintain sides and slopes of excavations in a safe condition until completion of backfilling.

H. Shoring and Bracing:
1. Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross-braces, in good serviceable condition.
2. Provide trench shoring and bracing to comply with local codes and authorities having jurisdiction. Refer to Specification Section 02156.
3. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Install shoring and bracing as excavation progresses.

I. Material Storage:
1. Stockpile excavated materials which are satisfactory for use on the work until required for backfill or fill. Place, grade and shape stockpiles for proper drainage and protect with temporary seeding or other acceptable methods to control erosion.
2. Locate and retain soil materials away from edge of excavations.

3. Dispose of excess soil material and waste materials as herein specified.

J. Dewatering:
   1. To ensure proper conditions at all times during construction, the Contractor shall provide and maintain ample means and devices (including spare units kept ready for immediate use in case of breakdowns) with which to intercept and/or remove promptly and dispose properly of all water entering trenches and other excavations (including surface and subsurface waters).
   2. Excavations shall be kept dry until the structures, pipes, and appurtenances to be built therein have been completed to such extent that they will not be floated or otherwise damaged. Refer to Specification Section 02401.

K. Cold Weather Protection:
   1. Protect excavation bottoms against freezing when atmospheric temperature is less than 35*F.
   2. No frozen material shall be used as backfill or fill and no backfill shall be placed on frozen material.

L. Separation of Surface Material:
   1. The Contractor shall remove only as much of any existing pavement as is necessary for the prosecution of the work.
   2. Prior to excavation, existing pavement shall be cut where in the opinion of the Engineer it is necessary to prevent damage to the remaining road surface.
   3. Where pavement is removed in large pieces, it shall be disposed of before proceeding with the excavation.
   4. From areas within which excavations are to be made, loam and topsoil shall be carefully removed and separately stored to be used again as directed; or, if the Contractor prefers not to separate surface materials, he shall furnish, as directed, loam and topsoil at least equal in quantity and quality to that excavated.

M. Dust Control:
   1. During the progress of the work, the Contractor shall conduct his operations and maintain the area of his activities, including sweeping and sprinkling of streets as necessary, so as to minimize the creation and dispersion of dust. Refer to Specification Section 01562.
   2. If the Engineer decides that it is necessary to use calcium chloride for more effective dust control, the contractor shall furnish and spread the material, as directed.

3.3 BACKFILL AND FILL

A. General:
   1. Backfilling shall consist of replacing material removed to permit installation of structures or utilities, as indicated in the Contract Documents.
   2. Filling shall consist of placing material in areas to bring them up to grades indicated on the Drawings.
   3. The Contractor shall provide and place all necessary backfill and fill material, in layers to the required grade elevations.

4. Backfill excavations as promptly as work permits, but not until completion of the following:

    a. Acceptance by Engineer of construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
    b. Inspection, approval, and recording locations of underground utilities.
    c. Removal of concrete formwork.
    d. Removal of shoring and bracing, and backfilling of voids with satisfactory materials. Temporary sheet piling driven below bottom of structures shall be removed in manner to prevent settlement of the structure or utilities, or cut off and left in place if required.
    e. Removal of trash and debris.
    f. Permanent or temporary horizontal bracing is in place on horizontally supported walls.
    g. Density testing having results meeting requirements specified herein.
5. In general, and unless otherwise indicated, material used for backfill of trenches and excavations around structures shall be suitable excavated material which was removed in the course of making the construction excavation. Unless otherwise specified or allowed by the Engineer the backfill and fill shall be placed in layers not to exceed 8 inches in thickness.
6. All fill and backfill under structures and pavement, and adjacent to structures, shall be compacted crushed stone or select fill as specified or as indicated on the Drawings. The fill and backfill materials shall be placed in layers not exceeding 8 inches in thickness.
7. All structures (including manholes) shall be placed on a 6-inch mat of screened stone unless otherwise indicated.
8. Suitable excavated material shall meet the following requirements:
    a. Free from large clods, silt lumps or balls of clay.
    b. Free from stones and rock fragments with larger than 12 inch max. dimension.
    c. Free from organics, peat, etc.
    d. Free from frozen material.
9. If sufficient suitable excavated material is not available from the excavations, and where indicated on the Drawings, the backfill material shall be select fill or common borrow, unless otherwise indicated, as required and as directed by the Engineer.
10. Do not backfill with, or on, frozen materials.
11. Remove, or otherwise treat as necessary, previously placed material that has frozen prior to placing backfill.
12. Do not mechanically or hand compact material that is, in the opinion of the Engineer, too wet.
13. Do not continue backfilling until the previously placed and new materials have dried sufficiently to permit proper compaction.

14. The nature of the backfill materials will govern the methods best suited for their placement and compaction. Compaction methods and required percent compaction is covered in Compaction section.
15. Before compaction, moisten or aerate each layer as necessary to provide a water content necessary to meet the required percentage of maximum dry density for each area classification specified.
16. Do not allow large masses of backfill material to be dropped into the excavation in such a manner that may damage pipes and structures.
17. Place material in a manner that will prevent stones and lumps from becoming nested.
18. Completely fill all voids between stones with fine material.
19. Do not place backfill on or against new concrete until it has attained sufficient strength to support loads without distortion, cracking, and other damage.
20. Deposit backfill and fill material evenly on all sides of structures to avoid unequal soil pressures.
21. Keep stones or rock fragments with a dimension greater than two inches at least one foot away from the pipe or structure during backfilling.
22. Leave sheeting in place when damage is likely to result from its withdrawal.
23. Completely fill voids left by the removal of sheeting with screened stone which is compacted thoroughly.

B. Pipe Bedding, Initial Backfill and Trench Backfill

1. Place bedding and backfill in layers of uniform thickness specified herein, and as shown on the Drawings.
2. Thoroughly compact each layer by means of a suitable vibrator or mechanical tamper.
3. Install pipe bedding and initial backfill in layers of uniform thickness not greater than eight (8) inches.
4. Deposit the remainder of the backfill in uniform layers not greater than eight inches.
5. Provide underground utility marking tape for new utility trenches as shown on the Drawings. Refer to Section 02650 – Buried Utility Markings.
6. Where soft silt and clay soils are encountered the trench shall be excavated six inches below the normal bedding and backfilled with 6-inches of compacted sand.
7. Backfill trenches with concrete where trench excavations pass within 18 inches of column or wall footings and which are carried below the bottom of such footings, or which pass under wall footings. Place concrete to the level of the bottom of adjacent footings.
8. The following schedule lists the bedding materials for various types of pipe. Refer to the pipe trench detail for dimensional requirements.

BEDDING REQUIREMENTS

DI or Concrete Pipe	screened stone or select fill.
PVC or PE Pipe	screened stone.

9. The following schedule lists the initial backfill requirements for various types of pipes. Refer to the pipe trench detail for dimensional requirements.

INITIAL BACKFILL REQUIREMENTS

DI or Concrete, Pipe	Screened stone or select fill
PVC or PE Pipe	Screened stone

10. Special bedding and backfill requirements shown on the Drawings supersede requirements of this section.
11. Where pipes or structures pass through or under the impervious core of the lagoon embankments, bedding and backfill material shall consist of the impervious embankment material. Extra care should be given to properly and thoroughly compact the bedding material around the pipe.

C. Improper Backfill:
1. When excavation and trenches have been improperly backfilled, and when settlement occurs, reopen the excavation to the depth required, as directed by the Engineer.
2. Refill and compact the excavation or trench with suitable material and restore the surface to the required grade and condition.
3. Excavation, backfilling, and compacting work performed to correct improper backfilling shall be performed at no additional cost to the Owner.

D. Ground Surface Preparation:
1. Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow, strip, scarify or break-up sloped surface steeper than 1 vertical to 4 horizontal.
2. When existing ground surface has a density less than that specified under "compaction" for the particular area classification, break up the ground surface, pulverize, moisture-condition to the optimum moisture content, and compact to required depth and percentage of maximum density.

3.4 COMPACTION

A. General:
1. Control soil compaction during construction to provide not less than the minimum percentage of density specified for each area classification.

B. Percentage of Maximum Density Requirements:
1. Compact soil to not less than the following percentages of maximum dry density determined in accordance with ASTM D1557 as indicated.
a. Structures: Compact each layer of backfill or fill material below or adjacent to structures to at least 95% of maximum dry density (ASTM D1557).
b. Off Traveled Way Areas: Compact each layer of backfill or fill material to at least 90% of maximum dry density (ASTM D1557).

c. Walkways: Compact each layer of backfill or fill material to at least 93% of maximum dry density (ASTM D1557).
d. Roadways, Drives and Paved Areas: Compact each layer of fill, subbase material, and base material to at least 95% of maximum dry density (ASTM D1557).
e. Pipes: Compact bedding material and each layer of backfill to at least 90% maximum dry density (ASTM D1557). Where backfilling with excavated material, compact to native field density.
f. Embankments: Compact each layer of embankment material to at least 95% of maximum dry density (ASTM D1557).

C. Moisture Control:
1. Where subgrade or a layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade, or layer of soil material, in quantities controlled to prevent free water appearing on surface during or subsequent to compaction operations.
2. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.
3. Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing until moisture content is reduced to a satisfactory level.

D. Embankment Compaction:
1. After each embankment layer has been spread to the required maximum 8-inch thickness and its moisture content has been adjusted as necessary, it shall be rolled with a sufficient number of passes to obtain the required compaction. One pass is defined as the required number of successive trips which by means of sufficient overlap will ensure complete coverage and uniform compaction of an entire lift. Additional passes shall not be made until the previous pass has been completed.
2. When any section of an embankment sinks or weaves excessively under the roller or under hauling units and other equipment, it will be evident that the required degree of compaction is not being obtained and that a reduction in the moisture content is required. If at any place or time such sinking and weaving produces surface cracks which, in the judgment of the Engineer are of such character, amount, or extent to indicate an unfavorable condition, he will recommend operations on that part of the embankment to be suspended until such time as it shall have become sufficiently stabilized. The ideal condition of the embankment is that attained when the entire embankment below the surface being rolled is so firm and hard as to show only the slightest weaving and deflection as the roller passes.
3. If the moisture content is insufficient to obtain the required compaction, the rolling shall not proceed except with the written approval of the Engineer, and in that event, additional rolling shall be done to obtain the required compaction. If the moisture content is greater than the limit specified, the material of such water content may be removed and stockpiled for later use or the rolling shall be delayed until such time as the material has dried sufficiently so that the

moisture content is within the specified limits. No adjustment in price will be made on account of any operation of the Contractor in removing and stockpiling, or in drying the materials or on account of delays occasioned thereby.

4. If because of insufficient overlap, too much or too little water, or other cause attributable to defective work, the compaction obtained over any area is less than that required, the condition shall be remedied, and if additional rollings are ordered, they will be done at no cost to the Owner. If the material itself is unsatisfactory or if additional rolling or other means fails to produce satisfactory results, the area in question shall be removed down to material of satisfactory density and the removal, replacement, and re-rolling shall be done by the Contractor, without additional compensation.
5. Material compaction by hand¬-operated equipment or power-driven tampers shall be spread in layers not more than 6 inches thick. The degree of compaction obtained by these tamping operations shall be equal in every respect to that secured by the rolling operation.

E. Compaction Methods: The Contractor may select any method of compaction that is suitable to compact the material to the required density.
1. General: Whatever method of compacting backfill is used, care shall be taken that stones and lumps shall not become nested and that all voids between stones shall be completely filled with fine material. All voids left by the removal of sheeting shall be completely backfilled with suitable materials and thoroughly compacted.
2. Tamping or Rolling: If the material is to be compacted by tamping or rolling, the material shall be deposited and spread in uniform, parallel layers not exceeding the uncompacted thicknesses specified. Before the next layer is placed, each layer shall be tamped as required so as to obtain a thoroughly compacted mass. Care shall be taken that the material close to the excavation side slopes, as well as in all other portions of the fill area, is thoroughly compacted. When the excavation width and the depth to which backfill has been placed are sufficient to make it feasible, and it can be done effectively and without damage to the pipe or structure, backfill may, on approval, be compacted by the use of suitable rollers, tractors, or similar powered equipment instead of by tamping. For compaction by tamping or rolling, the rate at which backfilling material is deposited shall not exceed that permitted by the facilities for its spreading, leveling, and compacting as furnished by the Contractor.

F. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, re-shape, and compact to required density prior to further construction.

3.5 GRADING:

A. General:
1. Grading shall consist of that work necessary to bring all areas to the final grades.
2. Uniformly grade areas within limits of work requiring grading, including adjacent transition areas.

3. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.

B. Grading Outside Building Lines:
   1. Grade areas adjacent to building to drain away from structures and to prevent ponding.
   2. Grade surfaces to be free from irregular surface changes, and as follows:
      a. Lawn or Unpaved Areas: Finish grade areas to receive topsoil to within not more than 1" above or below the required subgrade elevations.
      b. Walks: Shape surface of areas under walks to line, grade and cross-section, with finish surface not more than 1/2" above or below the required subgrade elevation.
      c. Pavements: Shape surface of areas under pavement to line, grade and cross-section, with finish surface not more than 3/8" above or below the required subgrade elevation.

C. Grading Surface of Fill Under Building Slabs:
   1. Grade surface to be smooth and even, free of voids, and compacted as specified, to the required elevation.
   2. Provide final grades within a tolerance of 1/2" when tested with a 10' straight edge.

D. Compaction:
   1. After grading, compact subgrade surfaces to the depth and percentage of maximum density for each area classification.

E. Protection of Graded Areas:
   1. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
   2. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.

3.6 BASE COURSE AND LEVELING COURSE

A. General:
   1. Base course consists of placing the specified materials in layers to support a leveling course or paved surface, as indicated in the Drawings.

B. Grade Control:
   1. During construction, maintain lines and grades including crown and cross-slope of base course and leveling course.

C. Placing:
   1. Place base course on prepared subbase conforming to indicated cross-section and thickness. Maintain optimum moisture content for compacting base materials.
   2. Place leveling course on prepared base course, conforming to indicated cross-section and thickness. Maintain optimum moisture content for compaction.

D. Shaping and Compacting:
   1. All layers of aggregate base course and leveling course shall be compacted to the required density immediately after placing. As soon as the compaction of any layer has been completed, the next layer shall be placed.

2. The Contractor shall bear full responsibility for and make all necessary repairs to the base leveling courses and the subgrade until the full depth of the base leveling courses is placed and compacted. Repairs shall be made at no additional cost to the Owner.
3. If the top of any layer of the aggregate base or leveling course becomes contaminated by degradation of the aggregate or addition of foreign materials, the contaminated material shall be removed and replaced with the specified material at the Contractor's expense.

END OF SECTION

SECTION 02260

FILTER FABRIC

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:
   1. Furnish all materials and install filter fabric of the types, dimensions and in the location(s) shown on the Drawings and specified herein.

B. Related Work Specified Elsewhere:
   1. Temporary Erosion Control is specified in Division 02270.

1.2 QUALITY ASSURANCE

A. A competent laboratory must be maintained by the manufacturer of the fabric at the point of manufacture to ensure quality control.

B. During all periods of shipment and storage, the fabric shall be wrapped in a heavy-duty protective covering to protect the fabric from direct sunlight, ultraviolet rays, temperatures greater than 140^{o}F, mud, dirt, dust and debris.

1.3 SUBMITTALS

A. Manufacturer shall furnish certified test reports with each shipment of material attesting that the fabric meets the requirements of this Specification.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Filter fabric for use in stabilization, drainage, underdrains, landscaping and beneath structures shall be formed in widths of not less than six (6) feet and shall meet the requirements of Table 1. Both woven and non-woven geotextiles are acceptable; however no "slit-tape" woven fabrics will be permitted for drainage, underdrain, and erosion control applications.

TABLE 1

Geotextile Mechanical Property	Test Method	Minimum Permissible Value
Grab Tensile Strength	ASTM D4632	120 pounds
Grab Elongation	ASTM D4632	50 percent
CBR Puncture Strength	ASTM D6241	310 pounds
Trapezoid Tear Strength	ASTM D4533	50 pounds
Water Flow Rate	ASTM D4491	120 gal/min/sf
Equivalent Opening Size (EOS)	ASTM D4751	U.S. Std. Sieve #80
Coefficient of Permeability	ASTM D4491	0.2 cm/sec

The geotextile shall have property values expressed in "typical" values that meet or exceed the values stated above as determined by the most recent test methods specified above.

B. For Silt Fence, refer to Section 02270 - Temporary Erosion Control Execution

PART 3 - EXECUTION

3.1 Install filter fabric as shown on the drawings or as directed in appropriate specifications in this division or in accordance with manufacturer's instructions or as directed by the engineer.

END OF SECTION

SECTION 02270

TEMPORARY EROSION CONTROL (NEW HAMPSHIRE)

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:
   1. The work under this section shall include provision of all labor, equipment, materials and maintenance of temporary erosion control devices as specified herein, and as directed by the Engineer.
   2. Erosion control measures shall be provided as necessary to correct conditions that develop prior to the completion of permanent erosion control devices or as required to control erosion that occurs during normal construction operations.
   3. Construction operations shall comply with all federal, state and local regulations pertaining to erosion control.
   4. After awarded the Contract, prior to commencement of construction activities, meet with the Engineer to discuss erosion control requirements and develop a mutual understanding relative to details of erosion control.

B. Related Work Specified Elsewhere:
   1. Site work is specified in appropriate sections of this Division.

C. Design Criteria:
   1. Conduct all construction in a manner and sequence that causes the least practical disturbance of the physical environment.
   2. Stabilize disturbed earth surfaces in the shortest time and employ such temporary erosion control devices as may be necessary until such time as adequate soil stabilization has been achieved.

1.2 SUBMITTALS

A. The Contractor shall furnish the Engineer, in writing, a work plan giving proposed locations for storage of topsoil and excavated material before beginning construction. A schedule of work shall accompany the work plan. Acceptance of this plan will not relieve the Contractor of the responsibility of completion of the work as specified.

1.3 QUALITY ASSURANCE

A. All materials and methods of erosion control shall meet the guidelines established by the "Stormwater Management and Erosion and Sediment Control handbook for Urban and Developing Areas in New Hampshire" prepared by the New Hampshire Natural Resources Conservation Commission.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Baled Hay:
   1. At least 14" by 18" by 30" securely tied to form a firm bale, staked as necessary to hold the bale in place.

B. Berms
   1. Berm shall be constructed of degradable woven silt sock material. No synthetic materials shall be allowed.
   2. Filtrexx SiltSoxx Natural Original silt sock or equivalent.

C. Sand Bags:
   1. Heavy cloth bags of approximately one cubic foot capacity filled with sand or gravel.

D. Mulches:
   1. Loose hay, straw, peat moss, wood chips, bark mulch, crushed stone, wood excelsior, or wood fiber cellulose.
   2. Type and use shall be as specified in "Stormwater Management and Erosion and Sediment Control Handbook for Urban and Developing Areas in New Hampshire" prepared by the NHDES, RECD, and the USDA Soil Conservation Service, herein after referred to as the NHSCH.

E. Mats and Nettings:
   1. Twisted Craft paper, yarn, jute, excelsior wood fiber mats, glass fiber and plastic film.
   2. Type and use shall be as specified in the NHSCH.
   3. East Coast Erosion Control EC-7Y Coir Mat or equivalent.

F. Permanent Seed:
   1. Conservation mix appropriate to the predominant soil conditions as specified in the NHSCH and subject to approval by the Engineer.

G. Temporary Seeding:
   1. Use species appropriate for soil conditions and season as specified in the NHSCH and subject to approval by the Engineer.

H. Water:
   1. The Contractor shall provide water and equipment to control dust, as directed by the Engineer.

I. Silt Fence:

1. Silt Fence shall be one of the commercially available brands, meeting the following requirements:

Geotextile Mechanical Property	Test Method	Minimum Permissible Value
Grab Tensile Strength (both directions)	ASTM D-4632	124 pounds
Puncture Strength	ASTM D-4833	60 pounds
Apparent Opening Size	ASTM D-4751	#30
Flow Rate	ASTM D-4491	8 gal/min/ft^2

2.2 CONSTRUCTION REQUIREMENTS

A. Temporary Erosion Checks:

1. Temporary erosion checks shall be constructed in ditches and other locations as necessary.
2. Baled hay, sand bags or siltation fence may be used in an arrangement to fit local conditions.

B. Temporary Berms:

1. Temporary barriers shall be constructed along the toe of embankments when necessary to prevent erosion and sedimentation.

C. Temporary Seeding:

1. Areas to remain exposed for a time exceeding 3 weeks shall receive temporary seeding as indicated below:

Season	Seed	Rate
Summer (5/15 - 8/15)	Sudangrass	40 lbs/acre
Late Summer/Early Fall (8/15 - 9/15)	Oats	80 lbs/acre
	Annual Ryegrass	40 lbs/acre
Fall (9/15 - 10/1)	Winter Rye	112 lbs/acre
Winter (10/1 - 4/1)	Mulch w/Dormant Seed	80 lbs/acre*
Spring (4/1 - 7/1)	Oats	80 lbs/acre
	Annual Ryegrass	40 lbs/acre

* seed rate only

D. Silt Fence shall be supported by posts and installed per the manufacturer's recommendations.

E. Mulch All Areas Receiving Seeding:

Use either wood cellulose fiber mulch (750 lbs/acre); or straw mulch with chemical tack (as per manufacturers specifications). Wetting for small areas may be permitted. Biodegradable netting is recommended in areas to be exposed to drainage flow.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Temporary Erosion Checks:

1. Temporary erosion checks shall be constructed in ditches and at other locations designated by the Engineer. The Engineer may modify the Contractor's arrangement of silt fences, bales and bags to fit local conditions.
2. Baled hay, silt fences, or sandbags, or some combination, may be used in other areas as necessary to inhibit soil erosion.
3. Siltation fence shall be located and installed as shown on plans or as required to comply with all Federal, State and Local Regulations.

B. Maintenance:

1. Erosion control features shall be installed prior to excavation wherever appropriate. Temporary erosion control features shall remain in place and shall be maintained until a satisfactory growth of grass is established. The Contractor shall be responsible for maintaining erosion control features throughout the life of the construction contract. Maintenance will include periodic inspections by the Owner or Engineer for effectiveness of location, installation and condition with corrective action taken by the Contractor as appropriate.

C. Removing and Disposing of Materials:

1. When no longer needed, material and devices for temporary erosion control shall be removed and disposed of as approved by the Engineer.
2. When removed, such devices may be reused in other locations provided they are in good condition and suitable to perform the erosion control for which they are intended.
3. When dispersed over adjacent areas, the material shall be scattered to the extent that it causes no unsightly conditions nor creates future maintenance problems.

END OF SECTION

SECTION 02444

CHAIN LINK FENCE AND GATES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:
   1. Furnish all materials and install chain link fence of the types, sizes and in the location(s) shown on the Drawings and specified herein.

B. Related Work Specified Elsewhere:
   1. Cast-in-place concrete is specified in Division 3.

1.2 QUALITY ASSURANCE

A. Acceptable Manufacturers:
   1. Anchor Fence, Inc.
   2. Fences Unlimited, Inc.
   3. On Guard Chain Link Fence
   4. Master Halco
   5. Richard's Fence
   6. Or equivalent.

1.3 SUBMITTALS

A. Submit satisfactory guarantees by the fence manufacturer covering any faults and defects in all parts of the fence arising from defective workmanship or materials for a period of one year from the date of installation.

PART 2 - PRODUCTS

2.1 FENCE MATERIALS

A. Posts:
   1. All posts: Galvanized steel, 35 percent minimum carbon content, 50,000 pounds per square inch minimum tensile strength.
   2. Line Posts: 2-3/8 inch O.D. pipe weighing 3.65 pounds per linear foot or 2 inch x 2-l/4 inch H section weighing 4.l0 pounds per linear foot.
   3. End, Corner, and Pull Posts: 2-7/8 inch O.D. pipe weighing 5.79 pounds per linear foot.
   4. Gate Posts: For single swing gates, or one leaf of double gates:
      a. Up to 6 feet wide: 2-7/8 inch O.D. pipe weighing 5.79 pounds per linear foot.
      b. 6 feet to l3 feet wide: 4 inch O.D. pipe weighing 9.ll pounds per linear foot.
   5. Post Tops: Tubular post tops designed to prevent moisture from entering posts and to support top rail.

B. All posts shall be of sufficient length to provide a 36 inch minimum setting in concrete footings, at a depth specified on the plans.

C. Top Rails:
   1. l-5/8 inch O.D. galvanized steel pipe weighing 2.27 pounds per linear foot.
   2. Provided with galvanized, outside sleeve, self-centering 7 inch long couplings approximately every 20 feet.
   3. Top rails shall pass through the post tops and form a continuous brace from end to end of each stretch of fence.
   4. Securely fasten top rails to the terminal and corner posts with heavy galvanized steel brace bands and rail end connections.

D. Horizontal Braces:
   1. Provide horizontal braces (brace rails) at all pull, corner, and terminal posts midway between top rails and ground and extend to the first adjacent line posts.
   2. Securely fasten braces to the line posts by brace ends and brace bands and to pull, corner and terminal posts by rail ends and brace bands.
   3. Braces shall be l-5/8 inch O.D. galvanized steel pipe weighing 2.27 pounds per linear foot with plain ends.
   4. Brace each corner and pull post on two sides.
   5. Brace each terminal post on one side.

E. Diagonal Braces:
   1. Provide diagonal braces (truss rods) from the brace ends on the line posts back to the bottom of pull, corner or terminal posts and fastened by brace bands.
   2. Diagonal braces shall be 3/8 inch diameter galvanized steel rods.
   3. Diagonal braces shall be provided with heavy galvanized iron turnbuckles to adjust the tension.

F. Fence Fabric:
   1. Wire: 9 gauge, 0.l48 inch diameter vinyl coated steel wire, of medium high carbon quality, minimum tensile strength of 80,000 pounds per square inch, interwoven into 2 inch diamond mesh.
   2. Fabric: 72 inches wide, selvage shall be knuckled at bottom and twisted and barbed at top.

G. Fabric Connections - Securely fasten fabric to:
   1. All terminal posts by l/4 inch x l/4 inch galvanized tension bars with ll gauge galvanized pressed steel bands spaced approximately l4 inches apart.
   2. All line posts with 6 gauge galvanized wire clips spaced approximately l4 inches apart.
   3. All top rails with 9 gauge galvanized tie wires spaced approximately 24 inches apart.
   4. The bottom edge of the fabric shall be fastened to a bottom tension wire with wire ties spaced approximately 24 inches apart.

2.2 GATE MATERIALS

A. Gate Frames:
   1. Fabricate from 2 inch O.D. steel pipe weighing 2.72 pounds per linear foot.
   2. All welded construction with malleable iron or pressed steel corner fittings. All welds shall be ground smooth to the surface plane of the base metals. Welding shall be performed prior to galvanizing.
   3. Frames shall be rigid enough to be free of twist or sag.

4. Gate leaves shall have truss rods or intermediate braces.

B. Truss Rods:
   1. Install 3/8 inch diameter truss rod on each gate.

C. Gate Fabric:
   1. Material and Fabrication: Identical to fence fabric.
   2. Installation: Securely fasten to gate with tension bars and hook bolts spaced approximately l5 inches apart.

D. Hinges:
   1. Hinges shall be structurally capable of supporting the gate leaf and allow the gate to open and close without binding. The hinges shall be so designed to permit the gate to swing a full 180°.
   2. Bottom Hinges: Wraparound adjustable type designed to carry the weight of the gate.
   3. Upper Hinges: Wraparound adjustable type.

E. Locking Devices:
   1. Positive type latching device with provision for padlocking.

F. Gate Keeper:
   1. Install on centerline of double gates.
   2. Gate keeper shall be adjusted with gate keeper rod to prevent opening of gate levers when padlocked.
   3. Fabricate from a 1-3/4 inch wide by 1-3/4 inch deep galvanized channelway approximately 7 inches long.
   4. Anchor into a l2 inch by 12 inch by 3 feet deep concrete foundation with a 1-1/2 inch O.D. galvanized steel pipe, l8 inches long, welded to the channelway.
   5. Slope top edges of channelway from center toward each end.
   6. Form concrete foundation to meet tops of channelway sides to prevent its removal.
   7. Obtain approval from the Engineer prior to installation of the gate keeper.

G. Outer Gate Catches:
   1. Material: Galvanized malleable iron or steel.
   2. Designed to anchor securely into l2 inch diameter by 3 feet deep concrete footing.
   3. Obtain approval from the Engineer prior to installation of outer gate catches.

2.3 WARNING SIGNS

A. When applicable, provide warning signs.

B. The number of signs, the location, size and wording shall be as shown on the Drawings or as directed by the Engineer.

C. Materials:
   1. Extruded aluminum shall be 0.080 inch thick.
   2. Hardware shall be 304 stainless steel clips, nuts and bolts.

PART 3 - EXECUTION

3.1 PREPARATION

A. Galvanizing:
   1. Hot dip galvanize all fence and gate materials.
   2. Minimum zinc coating shall be 2.0 ounces per square foot of surface.
   3. Galvanize all gate frames after fabrication.

3.2 INSTALLATION

A. Post Spacing:
   1. Equidistant in the fence line.
   2. Maximum spacing l0 feet on centers.

B. Post Setting:
   1. Set all posts plumb with tops aligned.
   2. Set all posts not less than 36 inches deep in concrete footings. Bottom of footings shall be at least 5' below finish grade. Slope top of footing to shed water.

C. Bracing: Brace gate, corner, end and pull posts to the next nearest post with a horizontal brace (compression member) and a diagonal truss rod and truss tightener (tension member).

D. Rails:
   1. Install rails before installing chain link fabric.
   2. Pass top rail through intermediate post caps.
   3. Provide expansion couplings spaced as recommended by manufacturer.

E. Gates:
   1. All gates shall open a full 180°.
   2. All gates shall open outward unless noted otherwise.

F. Alignment and Grade:
   1. Install fencing to the alignment shown on the Drawings or as directed by the Engineer.
   2. Changes in alignment of 30° or more shall be considered as corners.
   3. Install fencing to follow the general contour of the finished grades, unless otherwise shown on the Drawings or as directed by the Engineer.
   4. Install bottom edge of fence fabric approximately 2 inches above finished grade.

G. Placement of Fabric:
   1. Stretch fabric to a uniform finish as tight as possible without pulling the material out of shape.
   2. Place fabric on the faces of the posts away from the site.
   3. Place the top edge of the fabric parallel with the top rail.
   4. Provide all stretcher bars, bands, ties, and all other fastening devices, accessories, and appurtenances for the complete installation of fencing and gates.

5. Install fence fabric to provide approximately 2-inch deflection at center of span of fabric when a force of approximately 30 pounds is applied perpendicular to fabric. Fabric shall return to its original position when the force is removed.

END OF SECTION

SECTION 02465

DRILLED MICROPILE FOUNDATIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Installation and load testing of Drilled and Grouted Micropiles.
B. Installation and load testing of Helical Piles.

1.2 RELATED SECTIONS

A. Section 01300 - Submittals
B. Section 03300 – Cast-in-Place Concrete

1.3 REFERENCES

A. This section contains references that are applicable to this Specification Section. The applicable edition of the indicated references shall be the version that was the most current at the time of the Advertisement of Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued, or replaced.
B. AASHTO - Standard Specifications for Highway Bridges
C. AASHTO M85 - Standard Specification for Portland Cement
D. AASHTO T106M/T106 - Standard Method of Test for Compressive Strength of Hydraulic Cement Mortar (Using 50-mm or 2-in. Cube Specimens)
E. API RP 13B-1 - Field Testing Water-based Drilling Fluids
F. ASTM A29/A29M - Specification for Steel Bars, Carbon and Alloy, Hot-Wrought
G. ASTM A36/A36M - Specification for Carbon Structural Steel
H. ASTM A53/A53M - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
I. ASTM A153/A153M - Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware
J. ASTM A193/A193M - Specification for Alloy-Steel and Stainless-Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service
K. ASTM A252 - Specification for Welded and Seamless Steel Pipe Piles
L. ASTM A320/A320M - Specification for Alloy-Steel and Stainless-Steel Bolting Materials for Low Temperature Service
M. ASTM A325 - Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

N. ASTM A500/A500M - Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
O. ASTM A501 / A501M - Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
P. ASTM A513 - Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
Q. ASTM A536 - Specifications for Ductile Iron Castings
R. ASTM A572/A572M - Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
S. ASTM A615/A615M - Specification for Deformed and Plain Billet - Steel Bars for Concrete Reinforcement
T. ASTM A618/A618M - Specification for Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing
U. ASTM A656/A656M - Specification for Hot-Rolled Structural Steel, High-Strength Low-Alloy Plate with Improved Formability
V. ASTM A958 - Specification for Steel Castings, Carbon, and Alloy, with Tensile Requirements, Chemical Requirements Similar to Standard Wrought Grades
W. ASTM A1018/A1018M - Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Carbon, Commercial, Drawing, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
X. ASTM C33/C33M - Concrete Aggregates
Y. ASTM C94/C94M - Ready-Mixed Concretes
Z. ASTM C109/C109M - Compressive Strength of Hydraulic Cement Mortars (using 2-inch cube specimens)
AA. ASTM C150/C150M - Portland Cement
BB. ASTM C404 - Aggregates for Masonry Grout
CC. ASTM C494/C494M - Chemical Admixtures for Concrete
DD. ASTM D1143/D1143M - Test Methods for Deep Foundations Under Static Axial Compressive Load
EE. ASTM D3689 - Test Methods for Deep Foundations Under Static Axial Tensile Load
FF. ASTM D3966 / D3966M - Test Methods for Deep Foundations Under Lateral Load
GG. AWS D1.1/D1.1M - Structural Welding Code – Steel
HH. AWS D1.4/D1.4M - Structural Welding Code – Reinforcing Steel
II. ASCE 20 - Standard Guidelines for the Design and Installation of Pile Foundations
JJ. New Hampshire Building Code
KK. SAE J42 - Mechanical and Material Requirements for Externally Threaded Fasteners

1.4 DESIGN REQUIREMENTS

A. The intent of this Section is to specify the requirements for providing and installing reinforced, grouted, drilled micropiles or helical piles for the support of structural loads associated with the structures indicated on the Contract Drawings. The micropiles shall have a minimum design capacity in compression of 20 tons (unfactoredcompression) and 3 tons (unfactored tension), each with an appropriate factor of safety.

B. Drilled and Grouted Micropiles: The Contractor shall be responsible for furnishing all work, materials for the installation of drilled micropile foundations, micropile load test and design. The Work of this Section includes but is not limited to the following:
   1. All micro piles shall be designed by a Professional Engineer registered in the State of New Hampshire.
   2. Provide all equipment necessary for the installation of the micropiles to the minimum penetration depth into the underlying glacial till bearing strata as specified in the geotechnical report. Micropiles shall consist of permanent casing sections and fully reinforced grout sections. No load shall be transferred to the soils above the glacial till. Permanent casings shall be included as part of the micropiles and shall remain in place after grouting is complete. Temporary casings shall be installed if necessary, to facilitate micropile construction, and shall be removed during or after grouting. Temporary casings if used shall be approved as an accepted method. The Contractor is responsible for drilling through obstructions encountered during pile installation. Refer to the Data Report included in the Appendix of the Contract Specifications for more information on site subsurface conditions.
   3. Provide all methods, equipment and materials necessary for the protection of adjacent facilities. A facility is defined as a building, roadway, element of a utility system, or other construction structure.
   4. Transport off-site and legally dispose of excavation materials from the micropile foundations.
   5. Install drilled micropiles through whatever material encountered to the required depth, including removal or penetration of potential obstructions. Submit procedures that will ensure that drilling through the obstructions indicated in the Contract Documents will not damage the casing.
   6. Install permanent casing, steel reinforcement, and centering devices and grout placement as shown on the drawings and specified herein.
   7. Remove grout overpour or other irregularities which interfere with other structural elements, utilities, or other planned construction.

C. Helical Piles: The Contractor shall be responsible for furnishing all work, materials for the installation of Helical Pile foundations, pile load testing and design. All piles shall consist of either round shafts or square shafts. and consist of the following components:
   1. Starter section consisting of single or multiple helix plates welded to a central steel shaft.
   2. Helical extension consisting of one or more helical bearing plates welded to a central steel shaft of finite length.
   3. Plain Extensions consisting of central steel shaft segment without helix plates. The segments are connected with integral couplings and bolts. Plain extensions are used to extend the helix plates beyond the specified minimum depth and into competent load bearing stratum
   4. Pile cap embedded in the concrete foundation A minimum of 6-inches, or as shown on the contract drawings.

The Work of this Section includes but is not limited to the following:

1. Design of Helical Piles shall be performed by a Professional Engineer registered in the State of New Hampshire.
2. The allowable working load on the Helical Piles shall not exceed the following values:
   Compression: $P = 0.4*f_y*As$
   P = allowable working load in compression
   f_y = minimum yield strength of central steel shaft
   = 70 ksi (1 ½" square shaft, Type SS5)
   = 90 ksi (1 ¼", 1 3/8", 1 ½", 1 ¾", 2" and 2 ¼" square shafts)
   = 50 ksi (2 7/8", 3 ½" and 4 ½" diameter round shafts)
   A_s = area of central steel shaft
3. Tension: $T = S_{ut} / FS$
   T = allowable working load in tension
   S_u = minimum ultimate tensile strength of central steel shaft segment or coupling
   FS = factor of safety suitable for application = 2.0
4. All allowable working loads shall be reduced as required by the allowable load of the helix plates.
5. All designs must utilize a minimum factor of safety of 2.0 to convert the ultimate load capacity to a working load capacity.
6. Provide all equipment necessary for the installation of the helical piles to the minimum penetration depth into the underlying glacial till bearing strata as specified in the geotechnical report. No load shall be transferred to the soils above the glacial till. The Contractor is responsible for drilling through obstructions encountered during pile installation. Refer to the Data Report included in the Appendix of the Contract Specifications for more information on site subsurface conditions.
7. The overall length and installed torque of a Helical Pile shall be determined such that the required in-soil capacity is developed by end-bearing on the helix plate(s) in an appropriate strata(s).
8. All Pile caps shall be embedded a minimum 6-inches in the concrete foundation
9. Down-Drag/Negative Skin Friction: If Helical Piles with central steel shafts >4" in diameter are used in areas where compressible or decomposing soils overlie bearing stratum, or where expansive or frozen soils can cause pile jacking, Helical Pile shafts should be provided with a no-bond zone along a specified length to prevent load transfer that may adversely affect pile capacity. Alternately, Helical Piles can be provided with sufficient axial load capacity to resist down drag/negative skin friction forces.
10. Provide all methods, equipment and materials necessary for the protection of adjacent facilities. A facility is defined as a building, roadway, element of a utility system, or other construction structure.
11. The geotechnical information of the existing soils is included in the Appendix of the Contract Specifications.

D. Provide:
   1. All work and materials necessary for performance of a pile load test.
   2. Conform with additional requirements and restrictions imposed by the Owner on the Contractor's operations.

1.5 SUBMITTALS

A. Pre-Construction – The following shall be submitted prior to installation of the micropiles:
   1. Submit complete Shop Drawings stamped by a Professional Engineer registered in the State of New Hampshire in accordance with the provisions of Section 01300. Drawings should include complete dimensioned details, sizes, thicknesses, gauges, material, finishes, all connection details, anchorage details to concrete and other information as necessary to completely describe the micropile system.
   2. The Shop Drawings shall include the following:
      a. Pile number, location and pattern by assigned identification number
      b. Pile design load
      c. Type and size of pile
      d. Attachment to foundation
      e. Complete installation equipment, details and procedures.
   3. Submit qualifications of the micropile Contractor, including a project reference list and qualifications of the personnel assigned to the Project (including site foreman, surveyor and Engineer who will monitor and evaluate the pile load test). The project reference list shall include a brief description of the Project, Owner’s name and phone number.
   4. Submit welding procedures and qualifications of welders and tackers as specified in AWS D1.1 for casing steel and AWS Dl2 I D1.4 for reinforcing steel
   5. Description of equipment and procedures for installation of drilled micropiles including method of advancing the hole through soils, existing foundations, obstructions, voids, and boulders; method to assure the drilled hole has the minimum required diameter before grouting the drilled hole; the method to flush the drilled hole; and method of measuring volumes of grout to be placed for each drilled micropile and pressure grouting system details. Provide a description of the proposed installation sequence.
   6. Reinforcing steel details and centralizer type and locations and method of temporarily supporting the steel during grout placement.
   7. Submit plan describing how surface water, drill flush, and excess waste grout will be controlled and disposed.
   8. Submit description of equipment and methods of flushing the drill hole and checking the cleanliness of excavation and identifying the type of bearing material for consistency with design assumptions. Submit means of verifying that the drill hole has not collapsed and has the minimum required diameter prior to grouting the micropile.
   9. Submit means of monitoring verticality of the drill hole in the two principle perpendicular planes during excavation and details of proposed corrective measures to be implemented as necessary.

10. Submit cement grout mix design proposed for this work, with supporting strength data based on testing by an independent testing laboratory in accordance with AASHTO T106. Submit manufacturer's literature of any admixtures, methods of measuring volume of grout per micropile, and pressure grouting system details.
11. Submit tension load test location, procedures, and equipment. shop drawings with details of the load test setup including test micropile, reaction system layout, load cell and hydraulic jack, tell tales and strain gages, and anticipated subsurface conditions at the test pile location. The Engineer will determine the test location during Construction. Provide method of verifying load transfer of the full test load to the bearing stratum, which shall include a minimum of 5 strain gauges in the bearing stratum. The Contractor may need to use a heavier bar size (or stronger bar) to account for the load transfer and tension requirements. Provide reaction system design calculations prepared by a Professional Engineer registered in the Commonwealth of Massachusetts. Provide calibration records for the load cell and hydraulic jack to be used, prior to conducting the load test. Hydraulic jack calibration shall not be used in lieu of providing a separate load cell. Drilling for production drilled micropiles shall not begin until load test data have been reviewed by the Engineer.
12. Submit tension load test results.

B. Pre-Construction – The following shall be submitted prior to installation of the Helical piles:
    1. Submit complete Shop Drawings stamped by a Professional Engineer registered in the State of New Hampshire in accordance with the provisions of Section 01340. Drawings should include complete dimensioned details, sizes, thicknesses, gauges, material, finishes, all connection details, anchorage details to concrete and other information as necessary to completely describe the Helical Pile system.
    2. Submit complete structural design calculations stamped by a Professional Engineer registered in the State of New Hampshire.
    3. Submit complete installation details and procedures.
    4. The Shop Drawings shall include the following:
        a. Helical Pile number, location and pattern by assigned identification number
        b. Helical Pile design load
        c. Type and size of central steel shaft
        d. Helix configuration (number and diameter of helix plates)
        e. Minimum effective installation torque
        f. Minimum overall length
        g. Inclination of Helical Pile
        h. Cut-off elevation
        i. Helical Pile attachment to foundation
    5. Submit certified mill test reports for the central steel shafts. The ultimate strength, yield strength, percent elongation, and chemistry composition shall be provided.

6. Submit copies of calibration reports for each torque indicator or torque motor, and all load test equipment to be used on the project. The calibration tests shall have been performed within forty five (45) working days of the date submitted. Helical Pile installation and testing shall not proceed until the calibration reports have been submitted. These calibration reports shall include, but are not limited to, the following information:
    a. Name of Project and Contractor
    b. Name of testing agency
    c. Identification (serial number) of device calibrated
    d. Description of calibrated testing equipment
    e. Date of calibration
    f. Calibration data

C. Post-Construction – The following shall be submitted immediately after installation of the micropiles:
1. Submit as-installed records and drawings including the following information to the Owner and Engineer within one day after completing each micropile installation, including test piles. Data shall include:
    a. Drill log with pertinent information. A sample log is included at the end of this Section.
    b. Date and time of drilling and grouting.
    c. Drill bit type and size.
    d. Pile number, size, length, and location of pile.
    e. Sequence of installation.
    f. Condition of the bottom of the drill hole.
    g. Verticality information.
    h. Tip elevation of each pile to nearest 0.1 ft.
    i. Show locations of centers of as-installed piles on a drawing in relation to design location to the nearest 0.1 ft. Indicate magnitude and direction from plan location.
    j. Volume of grout used and injection pressure.
    k. Type of cement and water/cement ratio. Indicate admixtures used (if any).
    l. Reinforcing steel details, including elevation of splices to nearest 0.1 ft.
    m. Grout samples taken for testing.
    n. Elevation of centralizers to nearest 0.1 ft.
    o. Soil profile encountered during drilling to nearest 0.5 ft., including obstructions. Show each soil layer with approximate top and bottom elevations of each layer.
    p. Length, diameter, wall thickness and elevations of the top and bottom of the temporary drill casing used.
    q. Length and elevations of permanent steel casing used.
    r. Lengths of sockets below the permanent casing with the top and bottom elevations of the sockets.
2. Submit final as-drilled records of each pile installed to the Owner and Engineer within three (3) business days after completion of the Work of this Section.

3. Within 2 weeks after completion of all piles, submit a drawing, sealed by a surveyor registered in the Commonwealth of Massachusetts, showing the locations of the centers of as-driven piles in relation to the design location. Reference all as-drilled locations to established building lines as shown on the Contract Drawings. Drawing shall include the following.
    a. Column lines and north arrow.
    b. Each pile identified by a separate number.
    c. Elevation of each top of pile prior to cutting, to nearest 0.1 foot.
    d. Deviation in inches, to the nearest one-fourth inch, from plan location at cutoff elevation.

D. Post-Construction – The following shall be submitted immediately after installation of the Helical Piles:
1. Installation Records: Submit copies of Helical Pile installation records within 24 hours after each installation is completed. Formal copies shall be submitted on a weekly basis. These installation records shall include, but are not limited to, the following information.
    a. Name of Project and Contractor
    b. Name of Contractor's supervisor on-site personnel who will be involved with the work, including those who carry documented certification from the Helical Pile manufacturer.
    c. Date and time of installation
    d. Name and model of installation equipment
    e. Type of torque indicator used
    f. Location of Helical Pile by assigned identification number
    g. Actual Helical Pile type and configuration – including lead section (number and size of helix plates), number and type of extension sections (manufacturer's SKU numbers)
    h. Helical Pile installation duration and observations
    i. Total length of installed Helical Pile
    j. Cut-off elevation
    k. Inclination of Helical Pile
    l. Installation torque at one-foot intervals for the final 10 feet
    m. Comments pertaining to interruptions, obstructions, or other relevant information
    n. Rated load capacities
2. Test Reports: Submit copies of field test reports within 24 hours after completion of the load tests. Formal copies shall be submitted within a reasonable amount of time following test completion. These test reports shall include, but are not limited to, the following information:
    a. Name of Project and Contractor
    b. Name of Contractor's supervisor during installation
    c. Date, time, and duration of test
    d. Location of Helical Pile by assigned identification number
    e. Type of test (i.e. tension or compression)
    f. Description of calibrated testing equipment and test set-up

g. Actual Helical Pile type and configuration – including lead section, number and type of extension sections (manufacturer's SKU numbers)
h. Steps and duration of each load increment
i. Cumulative pile-head movement at each load step
j. Comments pertaining to test procedure, equipment adjustments, or other relevant information

3. Submit list of past installation projects completed within the last 5 years.
4. Submit Manufacturer's Warranty, in accordance with Paragraph 1.7 of this Specification.
5. Submit proposed load and test procedures in accordance with this Specification.

1.6 TOLERANCES

A. Micropiles:
1. Maximum variation of the center of any drilled micropile foundation from the required plan location, measured at the cut-off elevation, shall not exceed 3 inches.
2. The bottom diameter of the micropiles shall be no less than that shown on the Drawings, measured in any direction.
3. Maximum variation from vertical is 1 horizontal to 50 vertical (1:50) ratio.
4. Cut-off elevation of micropile shall be within ½ inch of elevation shown on the Drawings.
5. Centerline of reinforcing steel shall not be more than 0.5 inches from indicated center of pile.
6. Minimum volume of grout placed shall be the 100% of the theoretical volume of the whole micropile length from bottom to top at time of grouting.

B. Helical Piles:
1. Centerline of Helical Piles in plan: +/- 3 inches
2. Vertical plumbness: +/- 2°
3. Top elevation of Helical Pile: +1 inch to –2 inches

1.7 QUALITY ASSURANCE

A. Comply with all rules, regulations, laws, and ordinances State of New Hampshire and of all other authorities having jurisdiction.
B. The micropile Contractor shall be experienced in the construction and load testing of micropiles and have successfully constructed at least 5 projects in the last 5 years involving construction totaling at least 100 micropiles of similar subsurface materials, groundwater conditions, pile sizes, and special techniques as required in the Contract Documents.
C. The micropile Contractor shall employ:
1. Registered Professional Engineer in the State of New Hampshire to design load test set-up, and instrumentation for pile load test; monitor, record, and evaluate test results; prepare report on pile load test. The Engineer shall have at least 5 years of experience in drilled micropile design, installation, and pile load test setup, monitoring, and analysis.

2. Professional Land Surveyor or Engineer, registered in the State of New Hampshire, familiar with this type of work, to:
   a. Establish lines and grades.
   b. Establish actual pile locations.

D. The Helical Pile Contractor shall employ:
   1. Registered Professional Engineer in the State of New Hampshire to design load test set-up, and instrumentation for pile load test; monitor, record, and evaluate test results; prepare report on pile load test. The Engineer shall have at least 5 years of experience in Helical Pile design, installation, and pile load test setup, monitoring, and analysis.
   2. Professional Land Surveyor or Engineer, registered in the State of New Hampshire, familiar with this type of work, to:
      a. Establish lines and grades.
      b. Establish actual pile locations.

E. Helical Piles shall be installed by Contractors authorized and certified by the Helical Pile manufacturer. Contractor shall have satisfied the certification requirements relative to the technical aspects of the product and installation procedures as therein specified. The Helical Pile Contractor shall be trained and certified by the Helical Pile manufacturer in the proper methods of design and installation of Helical Piles.

F. The Contractor shall employ an adequate number of skilled workers who are experienced in the necessary crafts and who are familiar with the specified requirements and methods needed for proper performance of the work of this specification. Helical Pile components as specified herein shall be manufactured by a facility whose quality systems comply with ISO (International Organization of Standards) 9001 requirements.

G. The Helical Pile Contractor shall be experienced in performing design and construction of Helical Piles and shall furnish all materials, labor, and supervision to perform the work.

1.8 PROJECT CONDITIONS

A. Existing Structures and Utilities:
   1. The micropiles will be installed in the proximity of existing structures and subsurface utilities. Methods and equipment for installation of micropiles shall be consistent with the site conditions and shall be capable of installing the micropiles as shown on the Contract Drawings and specified herein.
   2. The Contractor shall field verify all existing conditions and notify the Engineer of any discrepancy, before performing any work.
   3. The Contractor shall consult Contract Drawings and official records of existing utilities, both surface and subsurface, and their connections, to be fully informed on all existing conditions and limitations as they apply to this Work and its relation to other construction Work.
   4. The Contractor shall protect existing structures from damage. This includes existing structures, parking and roadways, equipment, and utilities. The Contractor shall repair or replace any construction induced damage to the satisfaction of the governing authority at no additional cost to the Owner.

5. The Contractor shall protect existing utilities to remain in service within the drilled micropile installation Work zone in accordance with the requirements of authorities having jurisdiction over same.
6. Potential obstructions are indicated on the Contract Drawings including a previously installed foundation slab and sheet piling. The General Contractor shall dig test pits prior to construction to verify the locations and depths of the sheet piling.

B. Existing Subsurface Soil Data:
1. Logs of subsurface explorations performed at the site and approximate locations of these subsurface explorations provided in Geotechnical Data Report (included as an Appendix to the Specifications).
2. The aforementioned data is for general information and is accurate only at the particular locations and times the subsurface explorations were made. It is the Contractor's responsibility to make interpretations and draw conclusions based on the character of materials to be encountered and the impact on his work based on his expert knowledge of the area and of earthwork techniques. The Contractor shall review boring logs and locations and other pertinent data for the site. The Contractor, at his own expense, may conduct additional subsurface explorations for his own information after obtaining the Owner's permission.

1.9 PRE-INSTALLATION MEETING

A. Engineer shall hold meeting to discuss the pile installation materials and procedures more than 14 days prior to the pile installation.
B. Meeting Minutes: Engineer shall record minutes of meeting and distribute to attending parties, within 10 business days of meeting.
C. Attendance: General Contractor shall coordinate the attendance of the following parties: General Contractor’s superintendent and micropile installation subcontractor. Engineer shall coordinate the attendance of the following parties: Structural Engineer and Engineer’s Resident Project Representative.

1.10 STORAGE OF MATERIALS

A. Do not store materials directly on the ground.
B. Protect all materials from contact with moisture.
C. Maintain cement in dry condition. Do not stack cement such that the cement becomes compacted.
D. Store reinforcement on skids.
E. Remove defective materials from site. Do not store on site.

PART 2 - PRODUCTS

2.1 CEMENT GROUT

A. Cement grout shall be a mixture of Type I/II Portland Cement and potable water, Cement shall conform to AASHTO M85.

B. Grout shall have a minimum 7-day compressive strength of 4,000 psi and a minimum 28-day compressive strength of 5,000 psi based on testing in accordance with AASHTO T106.
C. Admixtures shall be used in accordance with manufacturer's recommendations.

2.2 STEEL REINFORCING BARS AND TIES

A. Reinforcing steel bars shall conform to ASTM A615/A615M Grade 75; deformed new materials. Cold-bent in accordance with CRSI 10MSP
B. Steel reinforcing bars and ties shall be free of rust, grease, oil, dirt, or other objectionable material at the time of placement into the micropile.
C. Reinforcing Steel Splice Couplings: Couplings shall develop at least 125 percent of the specified yield strength of the rebar in compression and tension. No lap splices shall be used.

2.3 MICROPILE STEEL CASING

A. Steel casing shall have a minimum outside diameter of 9-5/8" with a ½" wall thickness.
B. Steel casing for drilled piles shall conform to one of the following ASTM designations: A53, A500, A501, or A618 and shall be free of rust, grease, oil, dirt, or other objectionable material. The steel casing shall have a minimum yield strength of 80 ksi.
C. Casing shall be continuously joined and have the strength and rigidity to maintain the required micropile dimensions.
D. Permanent steel casing/pipe used as reinforcement shall be new and consist of ERW (Electric Resistance Welded) and/or seamless steel casing. No threaded casing joints shall be located within 3 feet of the pile cap.
E. The permanent casing shall incorporate an additional 1/16" thickness for sacrificial steel corrosion protection. Permanent steel casing shall 2 feet into the bedrock.
F. Centralizers: Provide as required to maintain alignment of reinforcing steel in the center of the drilled micropile. Centralizers shall be non-corrosive and non-metallic.

2.4 HELICAL PILE STEEL SHAFTS

A. Square shafts: ASTM A29.
    1. 1 ½" square: Shafts shall be hot rolled Round-Cornered-Square (RCS) solid steel bars with modified medium carbon steel grade (similar to AISI 1044)with improved strength due to fine grain size. Minimum yield strength fy =70 ksi.
    2. All other sizes: Shafts shall be hot rolled Round-Cornered-Square (RCS)solid steel bars with High Strength Low Alloy (HSLA), low to medium carbon steel grade with improved strength due to fine grain size. Minimum yield strength fy = 90 ksi.
B. Round shafts:
    1. 2 7/8" and 4 ½" diameter: ASTM A500 or A513. Shafts shall be structural steel tube or pipe, welded or seamless. Minimum yield strength fy = 50 ksi.
    2. 3 ½" diameter: ASTM A53, A252, A500 or A618. Shafts shall be structural steel tube or pipe, welded or seamless. Minimum yield strength fy = 50 ksi.
    3. Other shaft sizes as required by the pile manufacturer will be permitted.

2.5 HELIX BEARING PLATE

Bearing plates shall be hot rolled carbon steel sheet, strip, or plate formed on matching metal dies to true helical shape and uniform pitch. Bearing plate material shall conform to one of the following:

A. ASTM A572, A1018, or A656; fy = 50 ksi. Plate thickness = 3/8".
B. ASTM A572; fy = 50 ksi. Plate thickness = 3/8" or ½".
C. ASTM A656 or A1018; fy = 80 ksi. Plate thickness = 3/8" or ½".
D. ASTM A36 or A572; fy = 36 ksi. Plate thickness = 3/8" or ½".

2.6 BOLTS

The size and type of bolts used to connect the central steel shaft sections together shall conform to one of the following:

A. SAE J429 Grade 8 - 5/8" or ¾" diameter.
B. SAE J429 Grade 5 or 8 - ¾" diameter.
C. ASTM A320 Grade L7 or ASTM A325 - ¾" diameter.
D. ASTM A193 Grade B7 - 7/8" or 1 1/8" or 1 ¼" diameter.

2.7 COUPLINGS

The size and type of bolts used to connect the central steel shaft sections together shall conform to one of the following:

A. 1 ¼" and 1 3/8" thick square shafts: coupling shall be a cast steel sleeve with two holes for connecting shaft sections together.
B. All other square shafts: coupling shall be formed as an integral part of the plain and helical extension material as hot upset forged sockets
C. All round shafts: couplings shall either be formed as an integral part of the plain and helical extension material as hot forge expanded sockets, or as internal sleeve wrought steel connectors. The steel connectors shall be either tubing or solid steel bar with holes for connecting shaft sections together.

2.8 PILE CAPS

Pile cap shall be a welded assembly consisting of structural steel plates and shapes designed to fit the pile and transfer the design loads within safe allowable material capacities. Structural steel plates and shapes shall conform to ASTM A36 or ASTM A572 Grade 50.

2.9 FINISH

All helical anchors and accessories shall be hot-dipped galvanized in accordance with ASTM A153 or ASTM A123 after fabrication. Components to be fully embedded in concrete needn't be galvanized.

2.10 LOAD TEST

A. One (1) sacrificial test pile location will be determined by the Engineer, prior to installing micropiles. The tested pile shall include five (5) strain gauges positioned at near equal spacing from the top of the bearing zone to the tip of the pile.
B. Load cells and hydraulic jack, including complete assembly of pumps, gages, and ram to be used in the load test, shall be calibrated for this project by an approved laboratory within 2 weeks of the load test. A minimum of three calibration runs shall

be performed at ram extensions of one-inch, mid-range, and one inch less than full range.

C. Equipment type, reaction system, load instrumentation, and deflection monitoring shall conform to ASTM D3689.

D. Reaction frame shall be capable of safely supporting 150 percent of the maximum test load. The reaction frame design shall also be sufficient to account for an increase in the test load that might be required to ensure full load transfer to the bearing strata.

PART 3 - EXECUTION

3.1 PREPARATION FOR DRILLING

A. Contractor shall verify that site conditions will allow for access of proposed equipment and will support equipment for micropile installation.

B. The presence of existing structures, foundations, utilities, and other obstructions will require strict adherence to the installation criteria. Any interference encountered in the placement of piles shall be brought to the attention of the Engineer.

C. The Contractor shall employ a Registered Land Surveyor licensed in the Commonwealth of Massachusetts that is experienced with this type of work. The surveyor shall establish lines and levels and be responsible for the correct location of piles.

D. Establish a baseline and datum elevation as approved by the Engineer. Stake out locations of drilled micropiles. Maintain all location stakes and establish all elevations required, including the elevation of the top of pile, immediately after grouting and prior to cutting off any length of pile.

3.2 INSTALLATION OF MICROPILES

A. General method:

1. The method of micropile installation shall be determined by the Contractor. Micropile installation shall be made by non-displacement, low vibration methods such as rotary drilling. Wet rotary drilling shall employ sufficient pressure to provide complete removal of the drill cutting from the hole. Driving of casing will not be allowed.
2. Maintain stability of the drill hole walls during drilling with steel casing, as necessary to prevent cave-ins, settlement of the surrounding earth, water intrusion, and damage to adjacent facilities from construction operations. Steel casing shall be used from ground surface to at least 2 feet into the top of the bedrock stratum. Maintain a stable drilled hole that is open and clear for installation of steel reinforcement and cement grout. The drill hole shall not be advanced more than 2 feet below the bottom of casing when excavating below the groundwater level in all strata except bedrock.
3. Prior to installing reinforcing steel and cement grout, flush drill holes with water until all contaminated water and cuttings are removed and a clean return is observed. Use an internal circulation method which will not alter soil stability or aggravate existing environmental conditions. External flushing shall not be performed.

4. Monitor the drill holes at all stage to verify that the drill holes have not collapsed and have the specified diameter along their entire length. The Contractor shall provide access and assistance as requested by the Engineer to measure the depth to the bearing stratum to determine compliance with the specification requirements. The micropiles shall not be grouted until the drilled hole has been accepted by the Engineer.
5. Remove obstructions when encountered in accordance with the provisions of Part 3.5 of this Section.
6. Do not excavate new drill holes closer than 6 x pile diameter from a newly grouted micropile until the grout has been in place a minimum of 24 hours.
7. Micropile installation shall be completed, including placement of reinforcing steel and grouting, the same day the drilling of the micropile is completed.

B. Inspection
1. Drilled micropiles shall be installed to a depth no higher than the minimum rock socket lengths specified herein and as shown on the Drawings. If during installation of any mini-pile, there is either insufficient socket length at the minimum tip elevation or if the bearing strata within the socket length is of lower or higher quality than that shown on the Drawings, the depth of the micropile shall be adjusted so as to provide the required design capacities and specified minimum socket length for the bearing strata shown on the Drawings. The Engineer shall be the sole judge as to the classification of the material encountered during micropile installation and that the micropile has sufficient socket length.
2. In the presence of the Engineer, check that the drill hole has the specified minimum diameter along its entire length. The depth to final bottom of pile excavation shall be determined by observation of the drill stem length during drilling and the length of reinforcing steel installed.

3.3 INSTALLATION OF HELICAL PILES

A. Prior to commencing Helical Pile installation, the Contractor shall inspect the work of all other trades and verify that all said work is completed to the point where Helical Piles may commence without restriction.
B. The Contractor shall verify that all Helical Piles may be installed in accordance with all pertinent codes and regulations regarding such items as underground obstructions, right-of-way limitations, utilities, etc.
C. Installation Equipment:
1. Helical Piles should be installed with high torque, low RPM torque motors, which allow the helical screw plates to advance with minimal disturbance to the soil and adjacent structures. Percussion drilling equipment shall not be permitted.
2. Equipment shall be capable of applying adequate down pressure (crowd) and torque simultaneously to suit project soil conditions and load requirements. The equipment shall be capable of continuous position adjustment to maintain proper Helical Pile alignment.

D. Installation Tooling
1. Installation tooling should be maintained in good working order and safe to operate at all times. Flange bolts and nuts should be regularly inspected for

proper tightening torque. Bolts, connecting pins, and retainers should be periodically inspected for wear and/or damage and replaced with identical items provided by the manufacturer. Worn or damaged tooling should be replaced.

2. A torque indicator shall be used during Helical Pile installation. The torque indicator can be an integral part of the installation equipment or externally mounted in-line with the installation tooling. Torque indicators shall provide the following:
    a. Shall be capable of providing continuous measurement of applied torque throughout the installation.
    b. b. Shall be capable of torque measurements in increments of at least 500 ft-lb.
    c. Shall be calibrated prior to pre-production testing or start of work. Torque indicators which are an integral part of the installation equipment, shall be calibrated on-site. Torque indicators which are mounted in-line with the installation tooling, shall be calibrated either on-site or at an appropriately equipped test facility. Indicators that measure torque as a function of hydraulic pressure shall be calibrated at normal operating temperatures.
    d. Shall be re-calibrated if reasonable doubt exists as to the accuracy of the torque measurements.

E. Installation Procedures:
1. The Helical Pile installation technique shall be such that it is consistent with the geotechnical, logistical, environmental, and load carrying conditions of the project.
2. The lead section shall be positioned at the location as shown on the working drawings. The Helical Pile sections shall be engaged and advanced into the soil in a smooth, continuous manner at a rate of rotation as required. Extension sections shall be provided to obtain the required minimum overall length and installation torque. Connect sections together using coupling bolt(s) and nuts.
3. Sufficient down pressure shall be applied to uniformly advance the Helical Pile sections. The rate of rotation and magnitude of down pressure shall be adjusted for different soil conditions and depths.

F. Termination Criteria:
1. 1. The torque as measured during the installation shall not exceed the torsional strength rating of the central steel shaft.
2. The minimum required installation torque and overall length as determined by the Pile manufacturer shall be satisfied prior to terminating the Helical Pile installation.
3. If the torsional strength rating of the central steel shaft and/or installation equipment has been reached prior to achieving the minimum overall length required, the Contractor shall have the following options:
    a. Terminate the installation at the depth obtained following review with no exceptions taken by the Pile manufacturer.
    b. Remove the existing Helical Pile and install a new one with fewer and/or smaller diameter helix plates. The new helix configuration shall be subject to review and acceptance by the Pile manufacturer. If re-installing in the

same location, the top-most helix of the new Helical Pile shall be terminated at least (3) three feet beyond the terminating depth of the original Helical Pile.

c. Shaft material may not be reused after it has been permanently twisted during a previous installation or if the coupling bolt holes have been noticeably elongated during a previous installation.

4. If the minimum required installation torque is not achieved at the minimum overall length, and there is no maximum length constraint, the Contractor shall have the following options:
   a. Install the Helical Pile deeper using additional extension sections, or:
   b. Remove the existing Helical Pile and install a new one with additional and/or larger diameter helix plates. The new helix configuration shall be subject to review and acceptance by the Pile manufacturer. If re-installing in the same location, the top-most helix of the new Helical Pile shall be terminated at least (3) three feet beyond the terminating depth of the original Helical Pile.
   c. De-rate the load capacity of the Helical Pile and install additional Helical Pile(s). The de-rated capacity and additional Helical Pile location shall be subject to the review with no exceptions taken by the Pile manufacturer and Engineer.
5. If the Helical Pile is refused or deflected by a subsurface obstruction, the installation shall be terminated, and the pile removed. The obstruction shall be removed, if feasible, and the Helical Pile re-installed. If the obstruction can't be removed, the Helical Pile shall be installed at an adjacent location, subject to review with no exceptions taken by the Engineer.
6. If the torsional strength rating of the central steel shaft and/or installation equipment has been reached prior to proper positioning of the last plain extension section relative to the final elevation, the Contractor may remove the last plain extension and replace it with a shorter length extension. If it is not feasible to remove the last plain extension, the Contractor may cut the extension shaft to the correct elevation. The Contractor shall not reverse (back-out) the Helical Pile to facilitate extension removal.
7. The average torque for the last three feet of penetration shall be used as the basis of comparison with the required minimum installation torque. The average torque shall be defined as the average of the last three readings recorded at one-foot intervals.

3.4 INSTALLATION OF REINFORCING STEEL

A. Where it is not practical to deliver the reinforcing steel to the jobsite as a complete unit ready for installation, make splices on site prior to, or while lowering the assembly into the hole. Splices shall be capable of developing at least 125 percent of the specified yield strength in compression and tension of the specified reinforcing steel. No lap splices shall be used.

B. Prior to installation, inspect and clean reinforcing steel of materials that prevent effective bonding.

C. Place reinforcing steel in drill hole immediately after flushing the hole as specified herein. Lower reinforcing steel into the drill hole in such a manner to prevent dislodging soil from sides of excavation. Reinforcing steel shall be equipped with non-corrosive non-metallic centralizers to provide the specified minimum concrete cover, but in no case shall the spacing be greater than 10 feet. In addition, one centralizer shall be located within the bottom and top 2 feet of the reinforcement. Dropping or forcing reinforcing steel into the drill hole shall not be permitted. If the steel does not properly or smoothly enter the drill hole, it shall be retrieved, and the excavation adjusted and properly cleaned as specified until the reinforcing fits smoothly. Repair or replace any damaged reinforcing.

D. After installation of reinforcing steel and immediately prior to grout placement, the bottom of the excavation shall be measured to determine if sediment has accumulated. If sediment is found to have accumulated on the bottom of the drill hole, clean the bottom of the drill hole with equipment which is capable of removing the sediment.

3.5 PLACING GROUT

A. Place grout immediately after completion of drilling and placement of reinforcement. Grout shall be placed within 24 hours after completion of micropile drilling.

B. Place cement grout by the tremie method in accordance with PTI - M55.1 as applicable:

1. Advance permanent casing, as a minimum, to 2 feet below top of bedrock, prior to start of grout placement.
2. Mix the grout to produce a uniform mixture free of lumps and undispersed cement. Equip the pump with a pressure gauge to monitor grout pressures. Provide a pressure gauge capable of measuring pressure of at least 150 psi or twice the actual grout pressures used, whichever is greater. Use grouting equipment capable of pumping the grout in one continuous operation.
3. Place tremie hose to bottom of drill hole. Maintain tremie hose at least 5 feet below grout surface until casing is filled with grout. Continue to pump grout until grout contaminated with water or slurry from drill hole is no longer observed. Place grout in one continuous operation.
4. Place at least 110 percent of the theoretical volume of grout based on the outside diameter of casing.
5. Sample grout at least once each day that micropiles are grouted. Obtain grout samples from the end of the tremie grout hose. Preparation and testing of grout specimens shall be in accordance with ASTM C109, performed by the Independent Testing Laboratory (hired and paid for by the Owner).
6. Do not apply load to the micropiles until the grout has attained a compressive strength of 5,000 psi.

3.6 OBSTRUCTION REMOVAL DURING PILE INSTALLATION

A. Naturally occurring cobbles, boulders, clay stones, sand and gravel layers, and other dense, filled soils shall not be considered as obstructions. Encountering such conditions is to be anticipated and is consistent with the general nature of the subsurface conditions. The work and time associated with these conditions is incidental to and included in the cost to install the piles.

B. Additional obstructions are indicated on the Contract Drawings including a previously installed foundation slab and sheet piling. The General Contractor shall dig test pits prior to construction to verify the locations and depths of the sheet piling.

C. The Contractor shall notify the Engineer immediately upon encountering any potential obstruction which unavoidably and completely stops the advancement of the pile drilling progress. If the notification is verbal it shall be followed up in writing within 24 hours. The notification shall include all pertinent information relating to the nature, depth, plan location coordinates, expected extent of the potential obstruction, and methods the Contractor intends to use to overcome the potential obstruction. The Contractor shall also provide physical evidence, acceptable to the Engineer, of the material comprising the potential obstruction and evidence that the potential obstruction is not bedrock.

D. The Contractor shall remove or penetrate the obstruction. At all times during the removal of obstructions, the Contractor shall diligently pursue the removal of penetration of the obstructions using all the necessary and appropriate means and methods. The Contractor shall have on hand at all times, readily available, equipment, tool, materials, and labor appropriate for the effective removal of all types of potential obstructions. No payment shall be made for idle time due to the contractor's failure to have readily available such equipment, tools, materials, or labor.

E. Where obstructions make it impossible to install certain piles at locations shown on the Contract Drawings and/or to the proper depths, resort to all usual methods for pile installation. If in the judgment of the Owner or Engineer the Contractor is unable to complete the proper installation of any pile, after resorting to such methods, the Owner may require that an additional pile or piles be installed or that other remedial action be taken. Any pile abandoned because of obstructions encountered before reaching the design depth shall be filled with grout.

F. Fill with grout any drill holes which are abandoned at the direction of the Engineer because of unmovable obstructions.

3.7 MICRO PILE LOAD TEST

A. Perform one sacrificial pile tension load test in accordance with ASTM D3689, New Hampshire State Building Code (IBC Chapter 18), and as specified herein. The test location will be selected by the Engineer. The minimum test load shall be twice the maximum design load; however, the test load shall be increased to ensure twice the maximum compression load is transferred to the bearing strata.

B. The test pile shall be installed in the same manner as production drilled micropiles. The Contractor may elect to install the test pile such that the micropile will not develop friction resistance along the permanently cased section of the micropile.

C. Cast at least two 3/4-inch diameter PVC Schedule 40 pipes into the selected test pile to allow telltales to be installed for pile load testing. The pipes shall be securely fastened in straight alignment to prevent displacement during grouting. The pipes shall be sealed at the bottom with threaded steel caps and at the top with threaded PVC plugs. The pipes shall extend within one foot of the top and bottom of the bearing strata at the test pile location. At least five (5) strain gauges shall also be installed within the bearing stratum of the micropile with computerized monitoring to evaluate load distribution.

D. Do not begin load test until grout reaches the required design compressive strength. Allow a minimum of 5 days for the grout to cure.

E. Measure the load at the top of the pile with a load cell. Provide all instrumentation to be used, certified as accurate, if previously used, calibrated just prior to this work by an independent, certified testing agency.

F. Provide sufficient protection from the elements (rain, wind, etc.) and heating during the load test, as required, which could affect the test results. Provide heaters, ventilation, and lighting as necessary and required by the Engineer during testing.

G. Load bearing strata test pile to 200 percent of the allowable design load (DL) as indicated herein. The pile design load is indicated on the Contract Drawings. Position the jack at the beginning of the test such that the unloading and repositioning of the jack during the test will not be required. An Alignment Load (AL), shall be applied to the pile prior to setting the movement recording devices. Provide an Alignment Load no greater than 10 percent of the Design Load (i.e., 0.10 DL). Zero dial gauges after the first setting of AL.

H. Conduct load tests by loading the micropile and recording the micropile head movement in the cyclic load increments in the Load Test Schedule indicated below.
   1. Load Cycle 1:
      a. AL, 0.15 DL, 0.30 DL and 0.45 DL – 2.5 minutes each
   2. Load Cycle 2:
      a. AL, 0.15 DL, 0.45 DL – 1 minute each
      b. 0.60 DL, 0.75 DL, 0.90 DL, 1.00 DL – 2.5 minutes each
   3. Load Cycle 3:
      a. AL, 0.15 DL, 1.00 DL – 1 minute each
      b. 1.15 DL – 2.5 minutes
      c. 1.30 DL – 60 minute creep test
      d. 1.45 DL – 2.5 minutes
   4. Load Cycle 4:
      a. AL, 0.15 DL, 1.45 DL, 1.60 DL – 1 minute each
      b. 1.75 DL, 1.90 DL – 2 minutes each
      c. 2.0 DL – 10 minutes
      d. 1.50 DL, 1.00 DL, 0.50 DL, AL – 5 minutes each
   5. Record pile movement during creep testing at 1, 2, 3, 4, 5, 6, 10, 20, 30, 50, and 60 minute intervals. Hold creep test until pile meets the criterion indicated herein.

I. The acceptance criteria for micropile verification load tests are:
   1. Provide test piles to sustain the design load (1.0 DL) with no more than 0.5 inches (9.5 millimeters) of total vertical movement at the top of the pile as measured relative to the top of the pile prior to the start of testing.
   2. Provide test piles that have a creep rate at the end of the 1.30 DL increment that is not greater than 0.040 inch/log cycle time from 1 to 10 minutes or 0.080 inch/log cycle time from 6 to 60 minutes and has a linear or decreasing creep rate.
   3. Failure does not occur at the 2.0 DL maximum test load. Failure is defined as a slope of the load versus deflection (at end of increment) curve exceeding 0.025 inch/kip.

J. Grout and/or cut off test pile at least three feet below finish-grade following load test as directed by the Engineer.

K. Drilling for production micropiles shall not begin until load test data has been reviewed and accepted by the Engineer.

3.8 HELICAL PILE LOAD TESTS

A. The Contractor shall perform axial proof tests on three (3) of the total production Helical Piles. The Helical Piles to be tested will be selected by the Engineer.

B. The Contractor shall submit for review and acceptance the proposed Helical Pile load testing procedure. The proposal shall be in general conformance with ASTM D1143 and/or ASTM D3689, and shall provide the minimum following information:
   1. Type and accuracy of load equipment
   2. Type and accuracy of load measuring equipment
   3. Type and accuracy of pile-head deflection equipment
   4. General description of load reaction system, including description of reaction anchors
   5. Calibration report for complete load equipment, including hydraulic jack, pump, pressure gauge, hoses, and fittings.

C. Load Test Equipment
   1. 1. The load test equipment shall be capable of increasing or decreasing the applied load incrementally. The incremental control shall allow for small adjustments, which may be necessary to maintain the applied load for a sustained, hold period.
   2. The reaction system shall be designed so as to have sufficient strength and capacity to distribute the test loads to the ground. It should also be designed to minimize its movement under load and to prevent applying an eccentric load to the pile head. Test loads are normally higher than the design loads on the structure. The direction of the applied load shall be collinear with the Helical Pile at all times.
   3. Dial gauge(s) shall be used to measure Helical Pile movement. The dial gauge shall have an accuracy of at least +/-0.001-in. and a minimum travel sufficient to measure all Helical Pile movements without requiring resetting the gauge. The dial gauge shall be positioned so its stem is parallel with the axis of the Helical Pile. The stem may rest on a smooth plate located at the pile head. Said plate shall be positioned perpendicular to the axis of the Helical Pile. The dial gauge shall be supported by a reference apparatus to provide an independent fixed reference point. Said reference apparatus shall be independent of the reaction system and shall not be affected by any movement of the reaction system.
   4. The load test equipment shall be re-calibrated, if reasonable doubt exists as to the accuracy of the load or deflection measurements.

D. Testing Program
   1. 1. The hydraulic jack shall be positioned at the beginning of the test such that the unloading and repositioning of the jack during the test shall not be required. The jack shall also be positioned co-axial with respect to the pile-head so as to minimize eccentric loading. The hydraulic jack shall be capable of applying a load not less than two times the proposed design load. The pressure gauge shall

be graduated in 100 psi increments or less. The stroke of the jack shall not be less than the theoretical elastic shortening of the total Helical Pile length at the maximum test load.

2. An alignment load shall be applied to the Helical Pile prior to setting the deflection measuring equipment to zero or a reference position. The load shall be no more than 10% of the design load. After the load is applied, the test set-up shall be inspected carefully to ensure it is safe to proceed.
3. Axial compression and tension load tests shall be conducted by loading the Helical Pile in increments as indicated below in the table. Pile-head deflection shall be recorded at the beginning of each step and after the end of the hold time. The beginning of the hold time shall be defined as the moment when the load equipment achieves the required load step. Separate axial and tension tests shall be performed on each of the test piles.

   Load Cycle 1:
   a. AL – 1.0 minute

   Load Cycle 2:
   b. 0.2DL, 0.4DL, 0.60DL, 0.75DL, 0.90DL, 1.00DL, 1.20DL, 1.50DL – 2.5 minutes each

   Load Cycle 3:
   c. AL, 0.25 DL, 0.50 DL, 1.50 DL – 5 minute each

   Load Cycle 4:
   d. 1.75 DL, 2.0 DL – 2.5 minutes each

   Load Cycle 5:
   e. AL, 2.0DL – 10 minutes

   (Record pile movement during creep testing at 1, 2, 3, 4, 5, 6, 10, 20, 30, 50, and 60 minute intervals. Hold creep test until pile meets the criterion indicated herein. AL= Alignment Load, 10% of DL; DL=Design (Working) Load)

4. Test loads shall be applied until continuous jacking is required to maintain the load step or until the test load increment equals two times the design load, whichever occurs first. The observation period for this last load increment shall be 10 minutes. Displacement readings shall be recorded at 1, 2, 3, 4, 5 and 10 minutes (load increment maxima only). Displacement readings shall also be recorded at the end of each of the 1.0 DL load increments. The maximum permissible displacement at these increments is ¼ inch.
5. The applied test load shall be removed in four approximately equal decrements. The hold time for these load decrements shall be 1 minute, except for the last decrement, which shall be held for 5 minutes.
6. For a pile test to be considered successful, the Helical Pile shall sustain the compression and tension design capacities with the total vertical movement of the pile-head as measured relative to the top of the Helical Pile prior to the start of testing not exceeding the recommended value by the Pile manufacturer.
7. If a Helical Pile that is tested fails to meet the acceptance criteria, the Contractor shall be directed by the Engineer to load test another Helical Pile

in the vicinity. If a Helical Pile fails a load test, the Contractor shall install replacement Helical Pile, modifying the installation methods and equipment, as required by the pile manufacturer. Any modifications shall be performed at no additional cost to the Owner.

8. The Contractor shall provide the Engineer copies of field test reports confirming Helical Pile configuration, capacity, and construction details within 24 hours after
9. completion of the load tests. Formal copies shall be submitted as per Part 1.5.

3.9 NON-CONFORMING MICROPILES

A. Pile acceptance will be by the sole judgment of the Engineer. Piles that are non-conforming (as identified below), shall be cut off 12 inches below bottom of footing elevation and located on the Contractor's developed pile as-built drawing.

B. Non-conforming micropiles shall be identified as the following:
   1. Micropiles that are damaged.
   2. Micropiles that are installed out of tolerance.
   3. Micropiles at which the volume of grout placed is less than 110% of the theoretical volume of the drill hole or a sudden drop in grout level has been detected during grout placement or if grout placement is suspended for more than 2 hours.
   4. Micropiles for which the grout tests do not indicate the specified strength has been achieved.
   5. Micropiles that have not been installed to the required elevation.
   6. Micropiles that have not developed the specified socket length in the bearing stratum.
   7. Micropiles that otherwise are not installed as specified or directed.

C. All non-conforming micropiles shall be remediated, which shall include one of the following:
   1. Correction of the non-conforming micropile.
   2. Installation of supplemental micropiles.
   3. Installation of replacement micropiles.

D. All costs associated with remediation of non-conforming micropiles (except those caused by unforeseen conditions), including review of proposed remediation and any additional engineering analyses or redesign required by the remediation shall be borne by the Contractor. All proposed remediation of micropiles shall be reviewed with no exceptions taken by the Engineer prior to the start of remediation.

E. The Contractor shall be compensated for remediation of non-conforming piles that were caused by unforeseen conditions.

MICROPILE DRILLING LOG

MICROPILE #	DATE INSTALLED	GROUND ELEV	CASING CUTOFF ELEV	DEPTH FROM GROUND LEVEL	LENGTH BOH TO CUTOFF ELEV	CASED SHAFT DEPTH	ROCK SOCKET DEPTH	DATE GROUTED	ACTUAL VOL GROUT IN PILE	THEORETICAL VOL GROUT IN PILE

3.10 CLEARING

A. A. Upon completion of the pile installation, all materials and installation equipment shall be removed from the work area to permit installation of concrete foundations.

END OF SECTION

SECTION 02480

LANDSCAPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:

1. Perform the following items of work as required to complete the work of this section as shown on the Drawings and as specified hereunder:
    a. Spread stockpiled topsoil and furnish and spread any additional topsoil, required to meet the requirements of this section.
    b. Furnish and sow grass seed/or sod in all areas within the work area to the extent indicated on the Drawings, and in existing grass areas which have been damaged or disturbed by the work of this Contract.
    c. Furnish and install plant materials in all areas within the work area as indicated on the Drawings.
    d. Provide maintenance services as specified hereunder.

B. Examine all other sections of the Specifications and all Drawings for the relationship of the work under this section and the work of other trades. Cooperate with all trades in performing the work under this section.

1.2 SUBMITTALS AND TESTING

A. Seed:

1. Furnish the Engineer with duplicate signed copies of a statement from the vendor, certifying that each container of seed delivered to the project site is fully labeled in accordance with the Federal Seed Act and is at least equal to the specification requirements.
2. This certification shall appear in, or with, all copies of invoices for the seed.
3. Each lot of seed shall be subject to sampling and testing, at the discretion of the Engineer, in accordance with the latest rules and regulations under the Federal Seed Act.

B. Topsoil:

1. Inform the Engineer, within 30 days after the award of the Contract, of the sources from which the topsoil is to be furnished. It is the intent of this section that all topsoil which can be recovered from the site shall be used. Furnish additional topsoil as required.
2. Obtain representative soil samples, taken from several locations in the area under consideration for topsoil removal, to the full stripping depth.
3. Have soil samples tested by an independent soils testing laboratory, approved by the Engineer, at the Contractor's expense.
4. Have soil samples tested for physical properties and pH (or lime requirement), for organic matter, available phosphoric acid, and available potash, in accordance with standard practices of soil testing for agricultural use.
5. Approval, by the Engineer, to use topsoil for use in the work will be dependent upon the results of the soils tests.

C. Lime and Fertilizer:
   1. Furnish the Engineer with duplicate copies of invoices for all lime and fertilizer used on the project showing the total minimum carbonates and minimum percentages of the material furnished that pass the 90 and 20 mesh sieves and the grade furnished.
   2. Each lot of lime and fertilizer shall be subject to sampling and testing at the discretion of the Engineer.
   3. Sampling and testing shall be in accordance with the official methods of the Association of Official Agricultural Chemists.
   4. Upon completion of the project, a final check may be made comparing the total quantities of fertilizer and lime used to the total area seeded. If the minimum rates of application have not been met, the Engineer may require the Contractor to distribute additional quantities of these materials to meet the minimum rates.

1.3 DELIVERY, STORAGE AND HANDLING

A. Seed:
   1. Furnish all seed in sealed standard containers, unless exception is granted in writing by the Engineer.
   2. Containers shall be labeled in accordance with the United States Department of Agriculture's rules and regulations under the Federal Seed Act in effect at the time of purchase.

B. Fertilizer:
   1. Furnish all fertilizer in unopened original containers.
   2. Containers shall be labeled with the manufacturer's statement of analysis.

1.4 JOB CONDITIONS

A. Topsoil:
   1. Do not place or spread topsoil when the subgrade is frozen, excessively wet or dry, or in any condition otherwise detrimental, in the opinion of the Engineer, to the proposed planting or to proper grading.

B. Seeding and Planting:
   1. Work Seasons - Perform seeding and planting work only between the dates of 1 May to 20 June and 15 August to 1 October, except as otherwise directed in writing by the Engineer.
   2. Weather Conditions:
      a. Do not perform seeding work when weather conditions are such that beneficial results are not likely to be obtained, such as drought, excessive moisture, or high winds.
      b. Stop the seeding work when, in the opinion of the Engineer, weather conditions are not favorable.
      c. Resume the work only when, in the opinion of the Engineer, conditions become favorable, or when approved alternate or corrective measures and procedures are placed into effect.

PART 2 - PRODUCTS

2.1 MATERIALS FOR GRADING AND SEEDING

A. Topsoil:
   1. Fertile, friable, natural topsoil typical of the locality, without admixture of subsoil, refuse or other foreign materials and obtained from a well-drained site. Mixture of sand, silt, and clay particles in equal proportions.
   2. Free of stumps, roots, heavy of stiff clay, stones larger than 1-inch in diameter, lumps, coarse sand, weeds, sticks, brush or other deleterious matter.
   3. Not less than 4 percent nor more than 20 percent organic matter.
   4. Topsoil depth shall be 4-inches, unless otherwise indicated.

B. Fertilizer:
   1. Fertilizer shall be used to counteract soil deficiencies as indicated by the soil analysis and as approved by the Engineer. It should be a complete fertilizer, a standard product complying with the state and federal fertilizer laws, part of the elements of which are derived from organic sources, containing the following percentages by weight:

Nitrogen	10N - Minimum 75 percent organic
Phosphorus	6 P -
Potash	4 K -

      The fertilizer shall be delivered to the site in the original unopened containers bearing the manufacturer's guaranteed statement of analysis, or a manufacturer's certificate of compliance covering analysis shall be furnished to the Engineer. The fertilizer shall be spread at the rate of 17 to 20 lbs/1000 sq-ft.

C. Lime:
   1. Provide lime which is ground limestone containing not less than 85 percent of total carbonate and of such fineness that 90 percent will pass a No. 20 sieve and 50 percent will pass a No. 100 sieve.
   2. Coarser materials will be acceptable provided the specified rates of application are increased proportionately on the basis of quantities passing a No. 100 sieve. No additional payment will be made to the Contractor for the increased quantity.

D. Soil Enrichers:
   1. They shall be one of the following materials:
      a. Peat Moss - Finely shredded and consisting of not less than 90 percent organic matter.
      b. Sawdust - rotten.
   2. They shall be natural and suited to horticultural use. They shall not contain lumps, roots or other foreign matter over two inches in diameter. They shall be free from noxious weeds, seeds and other elements harmful to lawns. They shall be subject to inspection approval by the Engineer at the source and upon delivery and shall contain not more than 35 percent moisture by weight at the time of incorporation into the soil.

E. Mulch for Hydro Seeding:
   1. Mulch material shall meet the following requirements:
      a. Hay or straw - Hay or straw mulch shall consist of long fibered hay or straw, reasonably free from noxious weeds or other undesirable material. No material shall be used which is so wet, decayed, or compacted as to inhibit even and uniform spreading. No chopped hay, grass clippings or other short fibered material shall be used unless directed.
      b. Wood cellulose fiber - Wood cellulose fiber mulch shall consist of natural wood cellulose fiber containing no materials which will inhibit seed germination or plant growth. Sufficient non-toxic water soluble green dye shall be added to provide a definite color contrast to the ground surface to aid in even distribution. Wood fiber mulch shall be supplied in uniform packages not exceeding 100 pounds each. Each package shall be marked to show the air dry weight.

F. Mulch Binder for Hydroseeding:
   1. Material for mulch binder shall be emulsified asphalt.
      a. Emulsified asphalt mulch binder shall be a type acceptable to the Engineer and may be diluted with water to assure even distribution.

G. Grass Seed Mixture
   1. Fresh, clean, new crop seed. Seed may be mixed by an approved method on the site, or may be mixed by the dealer. If the seed is mixed on the site, each variety shall be delivered in the original containers which shall bear the dealer's guaranteed statement of the composition of the mixture and the percentage of purity of each variety. The Dealers Guarantee Statement shall be delivered to the Engineer.
   2. Grass seed shall be composed of the following varieties which shall be mixed in the proportions and shall test to 80 percent minimum purity, and 80 percent germination.

      Percent Proportion by Weight:

      a. MDOT Park Mixture:

i.	Creeping red fescue	50 percent
ii.	Kentucky Bluegrass	30 percent
iii.	Annual Rye Grass	20 percent

NOTE: Add 1 pound White or Dutch Clover per acre.

      b. MDOT Roadside Mixture (Slopes):

i.	Creeping Red Fescue	40 percent
ii.	Kentucky Bluegrass	25 percent
iii.	Kentucky 31 Fescue	30 percent
iv.	White Clover	5 percent

NOTE: Add 1 pound White or Dutch Clover per acre.

      c. Lawn Areas:

i.	Kentucky 31 Fescue	25 percent
ii.	Chewing Fescue	15 percent
iii.	Creeping Red Fescue	15 percent
iv.	Pennfine Perennial Rye	25 percent
v.	Lynn Perennial Rye	10 percent
vi.	Common Annual Rye	10 percent

H. Sod:
   1. Preferable two-year growth, at least 85 percent weed-free, solid landscaping sod composed of perennial fescues, Kentucky bluegrass's. Submit one 12 by 12 inch piece of sod, with source location, for approval of the Engineer, before ordering sod for the work.

2.2 MATERIALS FOR PLANTING

A. Water:
   1. The Contractor shall arrange and pay for water required for the planting. Water shall be clean and suitable for domestic consumption.

B. Manure:
   1. Manure shall be well rotted, unleached, horse or cow manure or a combination of both. It shall be free from any chemicals used to hasten decomposition artificially, or any other injurious substance.
   2. Manure shall be at least nine months old and not more than two years old, free from sawdust, hay, tanbark or wood shavings, or refuse of any kind. Manure shall consist of not more than 25 percent straw or other acceptable material.

C. Stakes shall be white cedar or approved equal, of size and length as shown on the Drawings.

D. Hose for guying shall be new black or green two-ply fiber garden hose, not less than 1/2 inch inside diameter. Seconds rejected by the factory are acceptable.

E. Burlap for wrapping shall be first quality burlap at least eight ounces in weight and six inches in width.

F. Wire for tree guys shall be galvanized annealed steel wire, No. 14 gauge, as detailed.

G. Tree paint shall be waterproof, adhesive and elastic, free from kerosene, coal tar creosote or any other material injurious to the life of the trees. Tree paint shall contain an antiseptic.

H. Pine bark mulch shall be clean, shredded, free of weeds, seeds, insects and extraneous materials.

I. Plant Materials:
   1. Plant materials shall conform to American Standard for Nursery Stock (April 15, 1951), sponsored by the American Association of Nurserymen, Inc., Standard Plant Names (1942) shall be the authority for plant names. Plant materials shall be of standard quality true to name and type and first class representatives of their species or variety.
   2. All plants shall conform to the varieties specified in the Plant List. No substitutions will be permitted unless approved in writing by the Engineer. Each bundle of plants and all separate plants shall be properly identified by name on legible, waterproof labels, securely attached thereto before delivery to the site.
   3. Plant materials shall be free of damage as a result of handling and transportation.
   4. All plant material shall be certified by the supplier to be free of disease and infestation.
   5. All plants shall be subject to approval at their source prior to shipment. The Contractor shall accompany the Engineer to inspect the materials, and shall request such inspection at least one week in advance.

6. All plants shall be typical of their species or variety and shall have a normal habit of growth. They shall be first quality, sound, healthy, vigorous, well branched and densely foliated. They shall be free of disease, insect pests, eggs or larvae, and shall have healthy, well-furnished root systems. Plants lacking compactness or proper proportions, and plants injured by too close planting in nursery rows will not be accepted.
7. All plants shall conform to the measurements specified in the Plant List. Measurements specified shall be the minimum acceptable for each variety. Plants that meet these requirements specified, but do not possess a normal balance between height and spread, will not be accepted. Plants shall not be pruned prior to delivery.
8. All plants and all tree trunks shall be measured when the branches are in their normal position. Dimensions noted for height and spread refer to the main body of the plant, and not from branch tip to branch tip. Height is defined as the approximate dimension from ground to top of last year's growth. Top spread is defined as the approximate spread to top or principal width. The height of tree trunks need not be specified if the required height can be obtained by pruning the lower branches without leaving unsightly scars or otherwise damaging the trunk. Shade trees shall be free of branches up to five feet, with a single leader, well branched and reasonably straight stems. No trees which have had their leaders cut, or are so damaged that cutting is necessary, will be accepted. Trees which had their tops cut off some years previous will only be acceptable if the scar has not decayed. No trees with cut off tops will be accepted unless corrective surgery has been performed so as to effect a complete healing of the stem.
9. Caliper of trees shall be measured one foot above ground.
10. Plants larger in size than those specified in the Plant List may be provided if approved by the Owner or the Engineer, but the use of larger plants shall not increase the cost of the Contract. If the use of larger plants is approved, the ball of earth or spread of roots shall be increased in proportion to the size of the plant. If plants required to be bare rooted are furnished in sizes greater than specified, they shall be balled and burlapped.
11. All trees shall have straight trunks with single leader intact. There shall be no abrasion of the bark and no fresh cuts of limbs over 1-1/4 inch which have not completely callused over.
12. All plants shall be grown in nurseries and cultivated, sprayed, pruned, and fertilized annually in accordance with good horticultural practice. All plants shall have been grown under climatic conditions similar to those in the locality of the project, or shall have been acclimated to the conditions of the locality for at least two years.
13. All plants shall be freshly dug; neither heeled in plants nor plants from cold storage will be accepted. All plants shall have been transplated or root pruned at least once in the past three years. Balled and burlapped plants shall come from soil which will hold a firm ball.

14. Plants marked "B&B" in the Plant List shall be adequately balled and burlapped with firm natural balls of soil, of diameter of sufficient depth to include all the roots. No plant required to be balled and burlapped shall be accepted if the ball is cracked or broken either before or during the process of planting, or when burlap, stakes, ropes or platform required in this connection have been removed.
15. All plants shall be handled so that the roots are adequately protected at all times. During shipment all plants shall be properly protected by a tarpaulin or other suitable covering.
16. No plants shall be so bound with rope or wire at any time so as to damage the bark, break branches, or destroy its natural shape. All balled and burlapped plants which cannot be planted immediately on delivery shall be set on the ground and well protected with soil or other acceptable material including watering. Until planted, all material shall be properly maintained.

2.3 STORAGE OF MATERIAL

A. Materials such as fertilizers, ground limestone, etc. shall be stored in weatherproof storage areas and in such a manner that their effectiveness will not be impaired.

PART 3 - EXECUTION

3.1 PREPARATION

A. Equipment:
   1. Provide all equipment necessary for the proper preparation of the ground surface and for the handling and placing of all required materials.
   2. Demonstrate to the Engineer that the equipment will apply materials at the specified rates.

B. Subsoil Preparation:
   1. Before spreading topsoil, the subgrade shall be raked by approved means. Remove all stones greater than four inches and all debris or rubbish to a depth of six inches. Such materials shall be removed from the site.

C. Screening:
   1. All topsoil shall be screened clear of all stones greater than one inch, sticks, plants, and all other foreign materials before being spread.
   2. During the screening of topsoil, commercial fertilizers and lime as required by the soil analysis shall be mixed with the topsoil so that they are evenly distributed throughout the screened topsoil.
   3. At the completion of this operation, topsoil is referred to as improved topsoil for the purpose of this specification and the Drawings.

3.2 SEED AND SOD BED PREPARATION

A. Spread improved topsoil uniformly over subgrade and all areas where the existing grade has been changed and areas disturbed by construction operations except for those areas indicated on the site plans to be paved. No subsoil, topsoil, or improved topsoil shall be handled in any way when in a wet or frozen condition.

B. Fine rake surface to receive seed or sod.
C. After natural settlement and a light rolling, the completed work shall conform to the lines, grades, pitches, and spot elevations shown on the plans.
D. Seeding may be done immediately thereafter, provided the seed bed has remained in a good friable condition and has not become wet.

3.3 SEASON

A. Do all seeding work within the dates herein specified.
B. If special conditions exist which may warrant a variance in the above dates, submit a written request to the Engineer stating the conditions and proposed variance. Permission for the variance will be given if, in the opinion of the Engineer, the variance is warranted.
C. If seeding is authorized between May 15 and August 15, annual rye shall be sown separately in addition to the specified seed mix. Sow at the rate of six to eight pounds per 1000 square feet.

3.4 SEEDING AND SODDING

A. Immediately before seeding and sodding, the ground shall be restored as necessary to a loose friable condition by discing or other approved method to a depth of not less than two inches. The surface shall be cleared of all debris and of all stones one inch or more in diameter.
B. Seed all areas to be seeded with the specified grass seed, sowing evenly with an approved mechanical seeder at the rate specified in the seed mix schedule. Sow one half the seed in one direction and the other half at right angles to the first seeding. Cultipacker or approved similar equipment may be used to cover the seed and to firm the seed bed in one operation. In areas inaccessible to Cultipacker, the seeded ground shall be lightly raked and rolled in two directions with a water ballast roller. Extreme care shall be taken during seeding and raking to insure that no change shall occur in the finished grades and that the seed is not raked from one spot to another.
C. The hydraulic spray method of sowing seed may be used where approved by the Engineer. This work shall be done with an approved machine operated by a competent crew. Seed and fertilizing materials shall be mixed with water in the tank of the machine and kept thoroughly agitated so the materials are uniformly mixed and suspended in the water at all times during operation. The spraying equipment must be designed and operated to distribute seed and fertilizing materials evenly and uniformly on the designated areas at the required rates. If the Engineer finds the application uneven or otherwise unsatisfactory, the Engineer may require the hydraulic spray method to be abandoned and the balance of the work done as specified herein. Seed must be lightly raked into the surface of the soil unless seeding is to be followed within 24 hours by mulching.
    1. Applying Mulch - At the option of the Contractor, any of the following types of mulch material may be applied.
        a. Hay or straw mulch shall be spread evenly and uniformly over the designated areas. Unless other directed, mulch shall be applied to a thickness of 1". Too heavy application of mulch shall be avoided and lumps and thick spots shall be thinned. Unless otherwise authorized, the mulch shall be anchored in place by uniformly applying an asphalt mulch

binder. Application of a concentrated stream of mulch binder will not be allowed. Asphalt mulch binder may be omitted when authorized by the Engineer and when there is a danger of the asphalt contaminating the surface of nearby structures, houses, vehicles, or other objects. Other methods of anchoring mulch may be used subject to the approval of the Engineer.

b. Wood fiber mulch shall be applied as a water-borne slurry. The wood fiber and water shall be thoroughly mixed and sprayed on the area to be covered so as to form a uniform mat of mulch at the rate of not less than 30 pounds per 1,000 square feet unit of area. Wood fiber mulch may be mixed with the proper quantities of seed, fertilizer and lime as required in this section, or may be applied separately after seeding has been carried out. In the latter case, it must be applied within 24 hours after seeding.

2. Maintenance - The Contractor shall maintain the mulch by repairing any damaged mulch and by correcting any shifting of the mulch due to wind, water or other causes, until an acceptable growth of grass has been achieved, regardless of the acceptance status of the seeding. The Contractor shall supply additional mulch necessary as a result of damage or seed failure. Repairs to mulched areas and furnishing of additional mulch shall be incidental to this item. If wood fiber is used, any reseeding will require additional wood fiber mulch.

D. Do not perform broadcast seeding work during windy weather.

E. Compacting:

1. Compact the entire area immediately after the seeding operations have been completed.
2. Compact by means of a cultipacker, roller, or other equipment approved by the Engineer weighing 60 to 90 pounds per linear foot of roller.
3. If the soil is of such type that a smooth or corrugated roller cannot be operated satisfactorily, use a pneumatic roller (not wobbly wheel) that has tires of sufficient size to obtain complete coverage of the soil.
4. When using a cultipacker or similar equipment, perform the final rolling at right angles to the prevailing slopes to prevent water erosion, or at right angles to the prevailing wind to prevent dust.

F. Thoroughly wet soil surfaces before sodding. Place sod pieces tightly together, tamping gently into position as the work progresses. After each area of sodding is completed, roll the entire surface in two directions with a water ballast roller, and soak the newly sodded areas.

After the grass has started, all of the areas greater than five square feet which fail to show a uniform stand of grass for any reason whatsoever shall be reseeded repeatedly until all areas are covered with a satisfactory growth of grass.

G. At the time of the first cutting, set mower blades two inches high. All lawns shall receive at least two mowings before acceptance. Schedule for mowing shall be coordinated with the Engineer.

H. Maintenance shall also include all temporary protection fences, barriers and signs and all other work incidental to proper maintenance.

I. Maintain grass areas until a full stand of grass is indicated, which will be a minimum of 45 days after all seeding or sodding work is completed, and shall not necessarily

relate to Substantial Completion of the General Contract.

J. Protection and maintenance of grass areas shall consist of watering, weeding, cutting, repair of any erosion and reseeding as necessary to establish a uniform stand of the specified grasses, and shall continue until Acceptance by the Engineer of the work of this section. It shall also include the furnishing and applying of such pesticides as are necessary to keep grass areas free of insects and disease. All pesticides shall be approved by Engineer prior to use.

3.5 SEEDING AND SODDING INSPECTION FOR PROVISIONAL ACCEPTANCE

A. The Engineer shall inspect all work for Provisional Acceptance upon written request of the Contractor. The request shall be received at least ten calendar days before the anticipated date of inspection.

B. Upon completion and reinspection of all repairs or renewals necessary in the judgment of the Engineer, the Engineer shall certify in writing to the Owner as to the Provisional Acceptance of the work of this section.

C. Upon approval of the Provisional Acceptance by the Owner, the Owner will assume maintenance of the lawn areas.

3.6 GUARANTEE

A. The Contractor shall submit a written guarantee to the Engineer, after Provisional Acceptance of grass, covering reseeding of grass areas which do not survive through one full growing season after the date of Provisional Acceptance, at no cost to the Owner.

3.7 CLEAN-UP

A. Any soil or similar material which has been brought on to paved areas by hauling operations or otherwise shall be removed promptly, keeping these areas clean at all time.

B. Upon completion of work under this section all excess stones, debris, and soil resulting from work under this section, which have not previously been cleaned up, shall be removed from the project site.

3.8 PLANTING METHOD

A. The Contractor shall excavate plant pits, furnish and place all plants, and then maintain them in a satisfactory manner until final acceptance.
All pits shall be of size and shape as shown on the Drawings.

B. For tree and shrub planting, soil used for backfilling shall be improved topsoil as recommended by soil analysis, with the following additions:
   1. For deciduous plants use a mixture of four parts topsoil and one part of manure.
   2. For evergreen plants use a mixture of four parts topsoil and one part of peat moss as specified under Soil Enrichers.

C. Plant pits within or near paved areas shall be prepared prior to the laying of the pavement. Where tree pits in paved areas are to be covered with mulch, trees shall be placed at sufficient depth below finished grade to allow for the depth of the mulch.

D. Plants shall be set plumb and straight, and at such a level that after settlement, a normal or natural relationship of the crown of the plant with the ground surface is established. Each plant shall be planted in the center of the pit. When balled,

burlapped and platformed plants are set, the platform shall first be removed from the pit and the soil shall be carefully tamped under and around the base of each ball to fill all voids. All burlap, ropes, and wires shall be removed from the sides and tops of balls, but no burlap shall be pulled out from under the balls, except for plastic burlap, which shall be completely removed from the pit.

E. All seals shall remain unbroken and visible on plant material until final inspection by Engineer. The Contractor shall remove all seals immediately after final inspection.

3.9 PLANTING SEASON

A. Do all planting work within the dates herein specified.

3.10 PRUNING, PAINTING, SPRAYING

A. Pruning:
   1. Each tree and shrub planted shall be pruned to preserve the natural character of the plant and in a manner appropriate to the particular requirements of the landscape design. In general, approximately one third of the wood shall be removed by thinning or shortening branches, but no leaders shall be cut.
   2. All pruning shall be done with sharp tools. All pruning cuts shall be made flush and clean, especially where lower branches have been removed from collected trees.

B. Painting:
   1. Pruning cuts over one-half inch in diameter shall be painted with tree paint specified under "Materials" on all exposed cambium as well as other exposed living tissues.

3.11 STAKING

A. All staking shall be done immediately after wrapping. Stakes shall be driven perpendicular into the ground around the periphery of the ball of the tree. Plants shall stand plumb after staking.

3.12 WATERING

A. Plantings shall be watered in a satisfactory manner during and immediately after planting, not less than twice per week, until provisional acceptance.

B. Suitable water for maintaining plants shall be provided by the Owner. The Contractor shall furnish the hose and hose connections from the outlets where water is furnished. Contractor is responsible for all watering until provisional acceptance.

3.13 MAINTENANCE

A. Maintenance shall begin immediately after each plant is planted. Plants shall be watered, mulched, weeded, fertilized, cultivated and otherwise maintained and protected until provisional acceptance.

B. Guys shall be tightened and repaired. Defective work shall be corrected as soon as possible after defects become apparent, and weather and season permit.

3.14 TREE SURGERY

A. Existing trees shall be trimmed of all dead and diseased limbs at the direction of the Engineer. All cuts shall be made close to the trunk and those over one inch in diameter shall be covered with an acceptable tree paint manufactured for this specific

purpose. In the case of important large trees where a small amount of cavity work would prolong their lives, such work should be done. The services of a qualified tree surgeon are recommended.

3.15 INSPECTION AND PROVISIONAL ACCEPTANCE

A. The Engineer will inspect all planting work for provisional acceptance upon request of the Contractor.

B. The Contractor shall furnish full and complete written instructions for maintenance of the planting to the Owner at the time of provisional acceptance.

C. After all necessary corrective work has been completed and maintenance instructions have been received by the Owner, the Engineer will certify in writing the provisional acceptance of the planting.

3.16 GUARANTEE PERIOD

A. All plants shall be guaranteed by the Contractor for a period of not less than one full year from time of provisional acceptance.

B. At the issuance of provisional acceptance, the Owner shall take over maintenance of the planting. Nevertheless, the guarantee of all plant material will remain with the Contractor. The Contractor shall ascertain that the Owner properly waters and maintains all planting during the one year guarantee period.

C. At the end of the guarantee period, any plant that is missing, dead, not true to name or size as specified, or not in satisfactory growth, as determined by the Engineer, shall be replaced. In case of reasonable doubt or question regarding the condition and satisfactory establishment of a rejected plant, the Engineer may allow such a plant to remain through another complete growing season, at which time the rejected plant, if found to be dead, in an unhealthy or badly impaired condition, shall be replaced at once. The Contractor will not be required to replace an inspected and accepted plant more than once.

D. Replacements shall be plants of the same kind and size as specified in the Plant List. They shall be furnished and planted as specified herein. The cost of replacement shall be borne by the Contractor, except where it can be definitely shown that loss resulted from Owner's failure to maintain planting as instructed.

3.17 FINAL INSPECTION AND FINAL ACCEPTANCE

A. At the end of the guarantee period, inspection will be made by the Engineer, at the request of the Contractor.

B. After all necessary corrective work has been completed, the Engineer will certify in writing the final acceptance of the planting.

3.18 CLEAN UP

A. Upon completion of work under this section, all excess stones, debris and soil resulting from planting work shall be removed from project site. The site shall be restored to a better condition than was present prior to construction.

END OF SECTION

SECTION 02485

LOAMING & SEEDING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Furnish, place, and test topsoil, seed, lime, and fertilizer where shown on the drawings and protect and maintain seeded areas disturbed by construction work, as directed by the Engineer.

B. Related Work Specified Elsewhere (When Applicable): Earthwork, excavation, backfill, compaction, site grading and temporary erosion control are specified in the appropriate Sections of this Division.

1.2 SUBMITTALS AND TESTING

A. Seed:

1. Furnish the Engineer with duplicate signed copies of a statement from the vendor, certifying that each container of seed delivered to the project site is fully labeled in accordance with the Federal Seed Act and is at least equal to the specification requirements.
2. This certification shall appear in, or with, all copies of invoices for the seed.
3. The certification shall include the guaranteed percentages of purity, weed content and germination of the seed, and also the net weight and date of shipment. No seed may be sown until the Contractor has submitted the certificates and certificates have been approved.
4. Each lot of seed shall be subject to sampling and testing, at the discretion of the Engineer, in accordance with the latest rules and regulations under the Federal Seed Act.

B. Topsoil:

1. Inform the Engineer, within 30 days after the award of the Contract, of the sources from which the topsoil is to be furnished.
2. Obtain representative soil samples, taken from several locations in the area under consideration for topsoil removal, to the full stripping depth.
3. Have soil samples tested by an independent soils testing laboratory, approved by the Engineer, at the Contractor's expense.
4. Have soil samples tested for physical properties and pH (or lime requirement), for organic matter, available phosphoric acid, and available potash, in accordance with standard practices of soil testing.
5. Approval, by the Engineer, to use topsoil for the work will be dependent upon the results of the soils tests.

C. Lime & Fertilizer:

1. Furnish the Engineer with duplicate copies of invoices for all lime and fertilizer used on the project showing the total minimum carbonates and minimum percentages of the material furnished that pass the 90 and 20 mesh sieves and the grade furnished.

2. Each lot of lime and fertilizer shall be subject to sampling and testing at the discretion of the Engineer.
3. Sampling and testing shall be in accordance with the official methods of the Association of Official Agricultural Chemists.
4. Upon completion of the project, a final check may be made comparing the total quantities of fertilizer and lime used to the total area seeded. If the minimum rates of application have not been met, the Engineer may require the Contractor to distribute additional quantities of these materials to meet the minimum rates.

1.3 DELIVERY, STORAGE & HANDLING

A. Seed:
   1. Furnish all seed in sealed standard containers, unless exception is granted in writing by the Engineer.
   2. Containers shall be labeled in accordance with the United States Department of Agriculture's rules and regulations under the Federal Seed Act in effect at the time of purchase.

B. Fertilizer:
   1. Furnish all fertilizer in unopened original containers.
   2. Containers shall be labeled with the manufacturer's statement of analysis.

1.4 JOB CONDITIONS

A. Topsoil: Do not place or spread topsoil when the subgrade is frozen, excessively wet or dry, or in any condition otherwise detrimental, in the opinion of the Engineer, to the proposed planting or to proper grading.

B. Seeding:
   1. Planting Seasons: The recommended seeding time is from April 1 to September 15. The Contractor may seed at other times. Regardless of the time of seeding, the Contractor shall be responsible for each seeded area until it is accepted.
   2. Weather Conditions:
      a. Do not perform seeding work when weather conditions are such that beneficial results are not likely to be obtained, such as drought, excessive moisture, or high winds.
      b. Stop the seeding work when, in the opinion of the Engineer, weather conditions are not favorable.
      c. Resume the work only when, in the opinion of the Engineer, conditions become favorable, or when approved alternate or corrective measures and procedures are placed into effect.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Seed:
   1. Provide the grass seed mixture approved by the Engineer, having the following composition:
      a. Park Mixture:
         50 percent Creeping Red Fesque

30 percent Kentucky Bluegrass
20 percent Annual Ryegrass

b. Roadside Mixture:

50 percent Creeping Red Fescue
15 percent Kentucky Bluegrass
5 percent White Clover
2 percent Red Top
3 percent Birdsfoot Trefoil
25 percent Annual Ryegrass

2. Do not use seed which has become wet, moldy, or otherwise damaged in transit or during storage.

B. Topsoil:
1. Fertile, friable, natural topsoil typical of the locality, without admixture of subsoil, refuse or other foreign materials and obtained from a well-drained site. Mixture of sand, silt, and clay particles in equal proportions.
2. Free of stumps, roots, heavy of stiff clay, stones larger than 1-inch in diameter, lumps, coarse sand, weeds, sticks, brush or other deleterious matter.
3. Not less than 4 percent nor more than 20 percent organic matter.
4. Topsoil depth shall be 4-inches, unless otherwise indicated.

C. Lime:
1. Provide lime which is ground limestone containing not less than 85% of total carbonate and of such fineness that 90% will pass a No. 20 sieve and 50% will pass a No. l00 sieve.
2. Coarser materials will be acceptable provided the specified rates of application are increased proportionately on the basis of quantities passing a No. l00 sieve. No additional payment will be made to the Contractor for the increased quantity.

D. Fertilizer:
1. Provide a commercial fertilizer approved by the Engineer.
2. Provide fertilizer containing the following minimum percentage of nutrients by weight:
l0% Available phosphoric acid
l0% Available potash
l0% Available nitrogen (75% of the nitrogen shall be organic)

PART 3 - EXECUTION

3.1 PREPARATION

A. Equipment:
1. Provide all equipment necessary for the proper preparation of the ground surface and for the handling and placing of all required materials.
2. Demonstrate to the Engineer that the equipment will apply materials at the specified rates.

B. Soil: Perform the following work prior to the application of lime, fertilizer or seed.
1. Scarify the subgrade to a depth of 2 inches to allow the bonding of the topsoil with the subsoil.

2. Apply topsoil to a depth of 4 inches or as directed on areas to be seeded.
3. Trim and rake the topsoil to true grades free from unsightly variations, humps, ridges or depressions.
4. Remove all objectionable material and form a finely pulverized seed bed.

3.2 PERFORMANCE

A. Grading:
   1. Grade the areas to be seeded as shown on the Drawings or as directed by the Engineer.
   2. Leave all surfaces in even and properly compacted condition.
   3. Maintain grades on the areas to be seeded in true and even conditions, including any necessary repairs to previously graded areas.

B. Placing Topsoil:
   1. Uniformly distribute and evenly spread topsoil on the designated areas.
   2. Spread the topsoil in such a manner that planting work can be performed with little additional soil preparation or tillage.
   3. Correct any irregularities in the surface resulting from topsoiling or other operations to prevent the formation of depressions where water may stand.
   4. Thoroughly till the topsoil to a depth of at least 3 inches by plowing, harrowing, or other approved method until the condition of the soil is acceptable to the Engineer. The surface shall be cleared of all debris and or stones one inch or more in diameter.

C. Placing Fertilizer:
   1. Distribute fertilizer uniformly at a rate determined by the soils test over the areas to be seeded.
   2. Incorporate fertilizer into the soil to a depth of at least 3 inches by discing, harrowing, or other methods acceptable to the Engineer.
   3. The incorporation of fertilizer may be a part of the tillage operation specified above.
   4. Distribution by means of an approved seed drill equipped to sow seed and distribute fertilizer at the same time will be acceptable.

D. Placing Lime:
   1. Uniformly distribute lime immediately following or simultaneously with the incorporation of fertilizer.
   2. Distribute lime at a rate determined from the pH test, to a depth of at least 3 inches by discing, harrowing, or other methods acceptable to the Engineer.

E. Seeding:
   1. Fine rake and level out any undulations or irregularities in the surface resulting from tillage, fertilizing, liming or other operations before starting seeding operations.
   2. Hydroseeding:
      a. Hydroseeding may be performed where approved and with equipment approved by the Engineer.
      b. Sow the seed over designated areas at a minimum rate of 5 pounds per 1000 square feet.
      c. Seed and fertilizing materials shall be kept thoroughly agitated in order to maintain a uniform suspension within the tank of the hydroseeder.

d. The spraying equipment must be designed and operated to distribute seed and fertilizing materials evenly and uniformly on the designated areas at the required rates.

3. Drill Seeding:
   a. Drill seeding may be performed with approved equipment having drills not more than 2 inches apart.
   b. Sow the seed uniformly over the designated areas to a depth of l/2 inch and at a rate of 5 pounds per l,000 square feet.
4. Broadcast Seeding:
   a. Broadcast seeding may be performed by equipment approved by the Engineer.
   b. Sow the seed uniformly over the designated areas at a rate of 5 pounds per l,000 square feet.
   c. Sow half the seed with the equipment moving in one direction and the remainder of the seed with the equipment moving at right angles to the first sowing.
   d. Cover the seed to an average depth of l/2 inch by means of a brush harrow, spike-tooth harrow, chain harrow, cultipacker, or other approved devices.
   e. Do not perform broadcast seeding work during windy weather.

F. Compacting:
1. Seeded areas must be raked lightly after sowing unless seeding is to be directly followed by application of an approved mulch.
2. Compact the entire area immediately after the seeding operations have been completed.
3. Compact by means of a cultipacker, roller, or other equipment approved by the Engineer weighing 60 to 90 pounds per linear foot of roller.
4. If the soil is of such type that a smooth or corrugated roller cannot be operated satisfactorily, use a pneumatic roller (not wobbly wheel) that has tires of sufficient size to obtain complete coverage of the soil.
5. When using a cultipacker or similar equipment, perform the final rolling at right angles to the prevailing slopes to prevent water erosion, or at right angles to the prevailing wind to prevent dust.

3.3 PROTECTION & MAINTENANCE

A. Protection:
1. Protect the seeded area against traffic or other use.
2. Erect barricades and place warning signs as needed.

B. Maintenance:
1. At the time of the first cutting, set mower blades two inches high. All lawns shall receive at least two mowings before acceptance. Coordinate schedule for mowing with Engineer.
2. Maintenance shall also include all temporary protection fences, barriers and signs and all other work incidental to proper maintenance.
3. Maintain grass areas until a full stand of grass is indicated, which will be a minimum of 45 days after all seeding work is completed, and shall not necessarily related to Substantial Completion of the General Contract.

4. Protection and maintenance of grass areas shall consist of watering, weeding, cutting, repair of any erosion and reseeding as necessary to establish a uniform stand for the specified grasses, and shall continue until Acceptance by the Engineer of the work of this section. It shall also include the furnishing and applying of such pesticides as are necessary to keep grass areas free of insects and disease. All pesticides shall be approved by Engineer prior to use.

3.4 ACCEPTANCE

A. At final acceptance of the project all areas shall have a close stand of grass with no weeds present and no bare spots greater than three inches (3") in diameter over greater than five percent (5%) of the overall seeded area.

END OF SECTION

SECTION 02513C

BITUMINOUS CONCRETE PAVING (NEW HAMPSHIRE)

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:
   1. Furnish all plant, labor, equipment and materials required to install bituminous concrete pavement courses, including sidewalks, driveways, temporary and permanent trench paving and restoration of pavement markings as shown on the Drawings and as specified herein.
   2. Remove bituminous asphaltic and/or Portland cement pavement, and replace bituminous asphaltic pavement, base, binder courses and surface courses, including temporary pavement, within the area(s) shown on the Drawings and as directed by the Engineer.
   3. Keep pavement removal to a minimum width suitable for the required construction.
   4. Apply pavement markings to the permanent paving as specified.

B. Work Not Included: Removal and replacement of paving for the convenience of the Contractor will not be considered for payment.

C. Related Work Specified Elsewhere (When Applicable):
   1. Excavation, backfill, aggregate base and subbase.

1.2 QUALITY ASSURANCE

A. Materials: Use only materials furnished by a bulk bituminous concrete producer regularly engaged in the production of hot mixed, hot laid bituminous concrete.

B. Equipment: Provide, maintain and operate pavers, dump trucks, tandem, 3-wheel and pneumatic tired rollers well suited to the mixtures being placed. Provide, maintain and operate hand equipment as required. When applicable, provide, maintain and operate trimming equipment and materials.

C. Mix Requirements, Method of Placement and Compaction: Standard Specifications for Road & Bridge Construction, State of New Hampshire, Department of Transportation, latest edition, hereinafter called NH DOT Standards for mixing, placing and compacting bituminous concrete surfaces are applicable to this work.

1.3 SUBMITTALS

A. A certificate of compliance shall be furnished to the Engineer that the materials supplied comply with the specification requirements.

B. Delivery slips shall be furnished with each load of mix delivered to the project. Information shall include:
   1. Vehicle identification.
   2. Date.
   3. Project.
   4. Identification of material.
   5. Gross, tare and net weights.

6. Signed by the bituminous concrete producer.
7. Stamped by a licensed public weigh master.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Hot Bituminous Paving Mix:
   1. Binder Course - 19.0 mm nominal maximum aggregate size.
   2. Surface Course - 12.5 mm nominal maximum aggregate size.
   3. Sidewalks and Drives - 9.5 mm nominal maximum aggregate size.

B. Composition of Mixtures - Control Points

SIEVE SIZE	GRADING			
	TYPE 25 mm	TYPE 19 mm	TYPE 12.5 mm	TYPE 9.5 mm
	PERCENT BY WEIGHT PASSING - COMBINED AGGREGATE			
37.5 mm	100			
25 mm	90-100	100		
19 mm	-90	90-100	100	
12.5 mm	-	-90	90-100	100
9.5 mm	-	-	-90	90-100
4.75 mm	-	-	-	-90
2.36 mm	19-45	32-42	42-52	46-56
1.18 mm	-	-	-	-
0.60 mm	-	-	-	-
0.30 mm	-	-	-	-
0.075 mm	1-7	2-8	2-10	2-10

C. Tack Coat:
   1. Emulsified type, Grade RS-1, CRS-1, HFMS-1, CSS-1, 1h

D. Pavement markings shall be in accordance with Section 02577.

PART 3 - EXECUTION

3.1 GENERAL

A. Grade Control:
   1. The Contractor shall establish and maintain the required lines and grades, including crown and cross-slope, for each course during construction operations.

B. Trench areas shall receive initial paving as the work progresses where trenches are in paved streets. Not more than 300 linear feet of backfill trench shall be left unpaved.

C. Reset all existing manholes to finished grade as required at no additional cost to the Owner.

3.2 PAVEMENT REMOVAL

A. General:
   1. Exercise extreme care in the removal of pavement so that pavement will not be unnecessarily disturbed or destroyed.
   2. Mechanically cut pavement to be removed to a straight line, unless otherwise directed by the Engineer.
   3. All pavement removed shall become the property of the Contractor and disposed of at acceptable locations designated by the Owner and at no additional cost to the Owner.

B. New Hampshire DOT Areas:
   1. When removing pavement under the jurisdiction of the New Hampshire Department of Transportation (NHDOT) strictly adhere to all DOT regulations controlling pavement openings.

3.3 SURFACE PREPARATION

A. Tack coats shall conform to the NH DOT Standard Specifications.

B. Tack Coat:
   1. Apply to contact surfaces of previously constructed asphalt or Portland cement concrete and surfaces abutting or projecting into asphalt concrete pavement. Distribute at rate of 0.05 to 0.15 gallons per square yard of surface.

3.4 PLACING THE MIX

A. General:
   1. Place asphalt concrete mixture on prepared surface. Minimum allowable temperature for placing is 250°F. Maximum shall be 325°F. Place in areas inaccessible to paving machine and small areas by hand. Place each course to required grade, cross-slope and compacted thickness.

B. Protection:
   1. After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened to the extent that the pavement will not be damaged.

3.5 PAVEMENT MARKINGS

A. Material, approved by the Engineer, is to be furnished and applied after the installation of permanent paving.

B. Apply pavement markings in accordance with existing markings. Match paint color, marking dimensions, layout and other details with existing markings in the vicinity of the project.

END OF SECTION

SECTION 02601

MANHOLES, COVERS AND FRAMES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Construct manholes, covers, frames, brick masonry, inverts and apply waterproofing in conformance with the dimensions, elevations, and locations shown on the Drawings and as specified herein.

B. Related Work Specified Elsewhere (when applicable):
   1. Final sewer testing is specified in this Division.
   2. Pipe, excavation, backfill, paving and dewatering are specified in the appropriate Sections in this Division.
   3. Concrete and grout are specified in Division 3.

1.2 QUALITY ASSURANCE

A. Precast Manhole Base, Barrel and Top Sections:
   1. Conform to ASTM C478-97 except as modified herein, and on the Drawings.
   2. Average strength of 4,000 psi at 28 days.
   3. Testing:
      a. Determine concrete strength by tests on 6-inch by 12-inch vibrated test cylinders cured in the same manner as the bases, barrels and tops.
      b. Have tests conducted at the manufacturer's plant or at a testing laboratory approved by the Engineer.
      c. Have not less than 2 tests made for each 100 vertical feet of precast manhole sections.

B. Frames and Covers:
   1. Acceptable Manufacturers:
      a. EJ Castings
      b. Neenah Foundry Company.
      c. Or equal

C. Masonry:
   1. Brick: Shall comply with the ASTM Standard Specifications for Sewer Brick (made from clay or shale), Designation C32, for Grade SS, hard brick.
   2. Cement: ASTM C-150.
   3. Hydrated Lime: ASTM C-207
   4. Sand: ASTM C144

D. Waterproofing:
   1. Acceptable Manufacturers:
      a. Karnak #220 AF Fibered Emulsion Dampproofing, Karnak Corp., Clark, NJ.
      b. PPS 922 Superseal, International Precast Supply.
      c. Or equal.

1.3 SUBMITTALS

A. Submit shop drawings and manufacturer's literature in conformance with Section 01340 and the Standard General Conditions of the Construction Contract.

B. Precast Manhole Sections: Submit test results and receive approval from the Engineer prior to delivery to the site.

PART 2 - PRODUCTS

2.1 PRECAST MANHOLE SECTIONS

A. Dimensions, shall be as shown on the Drawings:
   1. Base & Riser Sections:
      a. Diameter: As shown on the Drawings.
      b. Length: As required.
      c. Wall Thickness: Not less than 5 inches.
      d. Joints: Bell-and-spigot or tongue-and-groove formed on machine rings to ensure accurate joint surfaces.
   2. Tops:
      a. Diameter: Eccentric cone type, 30 inches I.D. at top, 48 inches I.D. at bottom unless otherwise shown on the Drawings.
      b. Length: 4 feet.
      c. Wall thickness: Not less than 5 inches at the base, tapering to not less than 8 inches at the top.
      d. Joints: Bell-and-spigot or tongue-and-groove formed on machine rings to ensure accurate joint surfaces.
      e. Exterior face of cone sections shall not flare out beyond the vertical.
   3. Flat Slab Tops:
      a. Location: Where shallow installations do not permit the use of a cone-type top and where indicated on the Drawings.
      b. Slab thickness: Not less than 6 inches.
      c. Constructed to support an HS-20 wheel loading.

B. Openings:
   1. Provide openings in the risers to receive pipes entering the manhole.
   2. Make openings at the manufacturing plant.
   3. Size: To provide a uniform annular space between the outside wall of pipe and riser.
   4. Location: To permit setting of the entering pipes at the correct elevations.
   5. Openings shall have a flexible watertight union between pipe and the manhole base.
      a. Cast into the manhole base and sized to the type of pipe being used.
      b. Type of flexible joint being used shall be approved by the Engineer. Install materials according to the Manufacturer's instructions.
         i. Lock Joint Flexible Manhole Sleeve made by Interpace Corporation.
         ii. Kor N Seal made by National Pollution Control System, Inc.
         iii. Press Wedge II made by Press-Seal Gasket Corporation.

iv. A-Lok Manhole Pipe Seal made by A-Loc Corporation.
v. Or equivalent.

C. Joints:
1. Joint gaskets to be flexible self-seating butyl rubber joint sealant installed according to manufacturer's recommendations. Install a double row of joint sealants for every manhole joint. For cold weather applications, use adhesive with joint sealant as recommended by manufacturer.
Acceptable Materials:
a. Kent-Seal No. 2
b. Ram-Nek
c. Or equivalent.
2. Joints between precast sections shall conform to related standards and manufacturer's instructions.
3. All manholes greater than 6 ft. diameter and all manholes used as wet wells, valve pits and other dry-pit type structures shall be installed with exterior joint collars. The joint collar shall be installed according to the manufacturer's instructions. Acceptable materials:
a. MacWrap exterior joint sealer as manufactured by Mar-Mac Manufacturing Company.
b. Or equivalent.

D. Waterproofing:
1. The exterior surface of all manholes shall be given two coats of waterproofing material at a application rate as recommended by the manufacturer.
2. The coating shall be applied after the manholes have cured adequately and can be applied by brush or spray in accordance with the manufacturer's written instruction.
3. Sufficient time shall be allowed between coats to permit sufficient drying so that the application of the second coat has no effect on the first coat.

2.2 FRAMES AND COVERS

A. Standard Units:
1. Made of cast iron conforming to ASTM A48-76, Class 30 minimum.
2. Have machined bearing surfaces to prevent rocking.
3. Castings shall be smooth with no sharp edges.
4. Constructed to support an HS-20 wheel loading.
5. Dimensions and Style shall conform to the Drawings, Standard castings differing in non-essential details are subject to approval by the Engineer:
a. Covers -solid with sewer in 3-inch letters diamond pattern.
b. Frame - 30-inch diameter clear opening, with flange bracing ribs.
6. Minimum weight of frame and cover shall be 370 lbs.

2.3 MASONRY

A. Brick:
1. Sound, hard, uniformly burned, regular and uniform in shape and size, compact texture, and satisfactory to the Engineer.

2. Immediately remove rejected brick from the work.

B. Mortar:
   1. Composition (by volume):
      a. 1 part Portland cement.
      b. 1/2 part hydrated lime.
      c. 4-1/2 parts sand.
   2. The proportion of cement to lime may vary from 1:1/4 for hard brick to 1:3/4 for softer brick, but in no case shall the volume of sand exceed 3 times the sum of the volume of cement and lime.

C. Cement shall be Type II Portland cement.

D. Hydrated lime shall be Type S.

E. Sand:
   1. Shall consist of inert natural sand.
   2. Grading:

Sieve	Percent Passing
No. 4	100
No. 8	95-100
No. 16	70-100
No. 30	40-75
No. 50	10-35
No. 100	2-15
No. 200	0-5

PART 3 - EXECUTION

3.1 PERFORMANCE

A. Precast Manhole Sections:
   1. Perform jointing in accordance with manufacturer's recommendations and as approved by the Engineer.
   2. Install riser sections and tops level and plumb.
   3. Make all joints watertight.
   4. When necessary, cut openings carefully to prevent damage to barrel sections and tops. Replace damaged manhole sections and tops at no additional cost to the Owner.
   5. When manhole steps are included in the Work, install barrel sections and tops so that steps are in alignment.

B. Drop Manholes:
   1. The difference in elevation between the invert of the inlet pipe and outlet pipe is to be either less than 6-inches (which does not require a drop manhole) or more than 24-inches (which does require a drop manhole).
   2. Where difference in elevation between the invert of the inlet pipe to the invert of the outlet pipe exceeds 24 inches, construct a drop manhole as shown on the Drawings or as directed by the Engineer.

C. Adjust to Grade:
   1. Adjust tops of manholes to grade with brick masonry.
   2. Concrete rings are not acceptable for adjusting to grade.
   3. In paved areas, set frame and cover to final grade after binder pavement is placed and the grade of surface pavement has been determined.

D. Pipe Connections to Manholes: Connect pipes to manholes with joint design and materials approved by the Engineer.

E. Invert Channels:
   1. After manhole and all pipes entering or exiting the manhole have been installed, construct the invert channels and shelf.
   2. Channels to be smooth and semicircular in shape conforming to the inside of the adjacent sewer section.
   3. Make changes in direction of flow with smooth curves having a radius as large as permitted by the size of the manhole.
   4. Stop the pipes at the inside face of the manhole where changes of direction occur.
   5. Form invert channels and shelf with brick.
   6. The maximum change in elevation from the invert of the inlet pipe to the invert of the outlet pipe is 6-inches. Shape invert to make smooth transition in vertical grade.
   7. Slope the floor of the manhole (shelf) to the flow channel, as shown on the Drawings.

F. Masonry:
   1. Laying Brick:
      a. Use only clean bricks in brickwork for manholes.
      b. Moisten the brick by suitable means until they are neither so dry as to absorb water from the mortar nor so wet as to be slippery when laid.
      c. Lay each brick in a full bed and joint of mortar without requiring subsequent grouting, flushing, or filling, and thoroughly bond as directed.
      d. Construct all joints in a neat workmanlike manner. Construct the brick surfaces inside the manholes so they are smooth with no mortar extending beyond the bricks and no voids in the joints. Maximum mortar joints shall be 1/2 inch.
      e. Outside faces of brick masonry shall be plastered with mortar from ¼-inch to 3/8-inch thick.
      f. Completed brickwork shall be watertight.
   2. Curing:
      a. Protect brick masonry from drying too rapidly by using burlaps which are kept moist, or by other approved means.
      b. Protect brick masonry from the weather and frost as required.

G. Frames and Covers:
   1. Set all frames in a full bed of mortar, true to grade and concentric with the manhole opening.
   2. Completely fill all voids beneath the bottom flange to make a watertight fit.
   3. Place a ring of mortar at least one inch thick around the outside of the bottom flange, extending to the outer edge of the manhole all around its circumference.

4. Clean the frame seats before setting the covers in place.

H. Plugging and Patching:
   1. Fill all exterior cavities with non-shrink grout and with bituminous waterproofing once the concrete and mortar has set.
   2. Touch up damaged water proofing.

I. Cleaning:
   1. Thoroughly clean manholes, steps, frames and covers of all debris and foreign matter.

J. Bedding and Backfilling:
   1. Bedding of manholes shall be 6 inches of 3/4" screened stone.
   2. Backfill a minimum of 18 inches all around manhole with gravel borrow.

3.2 MANHOLE TESTING

A. General:
   1. Perform a vacuum test on all manholes**.**
   2. All testing must be performed in the presence of the Engineer.
   3. Suitably plug all pipes entering each manhole and brace plugs to prevent blow out.

B. Vacuum Test:
   1. The manhole shall be tested by a vacuum test after assembly of the manhole, connection piping and backfilling. Vacuum testing to be conducted prior to construction of invert channels.
   2. Plug all lifting holes completely with non-shrink grout.
   3. Properly tighten all boot clamps and brace all plugs to prevent them from being sucked into the manhole.
   4. Install the testing equipment according to the manufacturer's instructions.
   5. A vacuum of 10 inches of Hg shall be drawn on the manhole and the loss of 1 inch of Hg vacuum timed. The manhole shall be considered to have passed the test if the time for the loss of 1 inch of Hg vacuum is:
      a. Greater than 2 minutes for manholes less than 10-feet deep.
      b. Greater than 2.5 minutes for manholes 10 to 15-feet deep.
      c. Greater than 3 minutes for manholes more than 15-feet deep.
   6. If the manhole fails the initial test, the Contractor shall locate the leak(s) and make repairs. The manhole shall be retested until a satisfactory test result is obtained.

C. Manhole Repairs:
   1. Correct leakage by reconstruction, replacement of gaskets and/or other methods as approved by the Engineer.
   2. The use of lead-wool or expanding mortar will not be permitted.

D. After the manholes have been backfilled and prior to final acceptance, any signs of leaks or weeping visible inside the manholes shall be repaired and the manhole made watertight.

END OF SECTION

SECTION 02615

DUCTILE IRON PIPE & FITTINGS (BURIED APPLICATIONS)

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Provide and install ductile iron pipe and fittings of the type(s) and size(s) in the location(s) shown on the Drawings and as specified herein.

B. Related Work Specified Elsewhere:
   1. Pipe and Pipe Fittings - General is specified in the appropriate Section in this Division.
   2. Excavation, Bedding and Backfill are specified in this Division.
   3. Ductile Iron Pipe & Fittings for Interior Applications is specified in Section 15062.

1.2 SUBMITTALS

A. Submit shop drawings in accordance with the applicable section of Division 1 and the General Conditions of the Construction Contract.

B. Submit manufacturer's "Certification of Conformance" that pipe and fittings meet or exceed the requirements of these Specifications.

C. Submit manufacturers installation instructions and specifications for all pipe and fittings.

1.3 QUALITY ASSURANCE

A. Standards (As Applicable):
   1. Cement-mortar lining for water: ANSI A2l.4 (AWWA C104).
   2. Rubber gasket joints: ANSI A2l.ll (AWWA C111).
   3. Ductile iron pipe thickness: ANSI A2l.50 (AWWA C150).
   4. Ductile iron pipe centrifugally cast in metal or sand lined molds: ANSI A2l.51 (AWWA C151).
   5. Pipe flanges and fittings: ANSI Bl6.l and ANSI A21.10 (AWWA C110).
   6. Threaded, flanged pipe: ANSI A21.15 (AWWA C115).
   7. Cast and ductile iron fittings: ANSI A2l.l0 (AWWA C110).

B. Acceptable Manufacturers:
   1. Tyler
   2. Griffin
   3. Union
   4. US Pipe
   5. Or equivalent.

1.4 DELIVERY, STORAGE & HANDLING

A. Exercise extra care when handling ductile iron pipe because it is comparatively brittle.

B. Exercise extra care when handling cement lined pipe because damage to the lining will render it unfit for use.

C. Protect the spherical spigot ends and the plain ends of all pipe during shipment by wood lagging securely fastened in place.

PART 2 - PRODUCTS

2.1 PIPE MATERIALS

A. General:

1. All exterior (buried) ductile iron pipe shall have push-on or mechanical joints unless otherwise specified or shown on the Drawings. Pipe within valve pits and other structures is considered interior pipe and shall be flanged.
2. Unless otherwise shown on the Drawings or in the pipe schedule, the minimum thickness of ductile iron pipe shall be:
   a. For pipe 4 inches in diameter: Class 52.
   b. Pipe with flanges: Class 53.
3. Pipe for use with sleeve type couplings shall have plain ends (without bells or beads) cast or machined at right angles to the axis.
4. Pipe shall be double thickness cement lined and seal coated unless noted otherwise on the Drawings, and except for air piping lines which shall be completely unlined.
5. Pipe for use with split type couplings shall have ends with cast or machined shoulders or grooves that meet the requirements of the manufacturer of the couplings.
6. Factory applied bituminous coatings (in accordance with AWWA C151) shall be furnished on the exterior of all underground piping unless specified otherwise.
7. The outside of pipe within structures and exposed shall not be coated with bituminous coating, but shall be thoroughly cleaned and given one shop coat of Intertol Rustinhibitive Primer 621 by Koppers Co.; Multiprime by PPG Industries; Chromox 13R50 Primer made by Mobil Chemical Co.; or equivalent.

B. Joints (as shown on Drawings or as specified):

1. Push-on and Mechanical Joint:
   a. The plain ends of push-on pipes shall be factory machined to a true circle and chamfered to facilitate fitting the gasket.
   b. Provide gaskets manufactured from a composition material suitable for exposure to the fluid to be contained within the pipe. On high temperature applications such as air lines, the gaskets shall be suitable for service from 40*F to 250*F.
   c. Bolts and nuts for buried mechanical joints shall meet the AWWA C-111 requirements and be made of high strength, low alloy steel.
2. Flanged:
   a. Provide specially drilled flanges when required for connection to existing piping or special equipment.

b. Flanges shall be long-hub screwed tightly on pipe by machine at the foundry prior to facing and drilling.
c. Gaskets:
    i. Ring type of rubber with cloth insertion.
    ii. Thickness of gaskets l2 inches in diameter and smaller: l/l6 inch.
    iii. Thickness of gaskets larger than l2 inches in diameter: 3/32 inch.
    iv. On high temperature applications such as air lines, the gaskets shall be suitable for service from 40°F to 200°F.
d. Fasteners:
    i. Make joints with bolt, studs with a nut on each end, or one tapped flanged with a stud and nut.
    ii. The number and size of bolts shall meet the requirements of the applicable ANSI standard.
    iii. Nuts, bolts, and studs shall be Grade B meeting the requirements of ASTM A307.
    iv. After jointing, coat entire joint with bituminous material compatible with pipe coating unless other coating required by Section 09900.
e. When applicable, provide and install flange clamps as shown on the Drawings.

3. Joint Bracing:
    a. Provide joint bracing to prevent the piping from pulling apart under pressure as required and as shown on the Drawings.
    b. Types of bracing:
        i. Pipe and fittings furnished with approved lugs or hooks cast integrally for use with socket pipe clamps, tie rods, or bridles. Bridles and tie rods shall be a minimum of 3/4 inch diameter except where they replace flange bolts of a smaller size, in which case they shall be fitted with a nut on each side of the pair of flanges. The clamps, tie rods, and bridles shall be coated with bituminous paint in buried installations and shall be coated with the same coatings as the piping system in interior installations after assembly or, if necessary, prior to assembly.
        ii. Mechanical joint follower gland pipe restrainers.
            (1) Ductile iron gland and restraining ring.
            (2) Gasket shall be standard MJ gasket -ANSI/AWWA-C111/A21.11.
            (3) Working pressure 350 psi, up to 8 inches; 250 psi, 10 inches to 16 inches.
            (4) Test pressure two times working pressure.
            (5) Grip Rings™, Romac Industries, or other equivalent as approved by Engineer.
        iii. Other types of bracing as shown on the Drawings.

2.2 FITTINGS

A. Standard Fittings:
   1. Pressure rating of 250 psi for all fittings unless indicated otherwise on the Drawings or as specified.
   2. Joints the same as the pipe with which they are used or as shown on the Drawings.
   3. Cement lining and seal coat as specified for pipe.
   4. Factory applied bituminous coatings shall be furnished for all underground fittings.

PART 3 - EXECUTION

3.1 INSPECTION

A. Provide all labor necessary to assist the Engineer to inspect pipe, fittings, gaskets, and other materials.
B. Carefully inspect all materials at the time of delivery and just prior to installation.
C. Carefully inspect all pipe and fittings for:
   1. Defects, such as weak structural components, that adversely affect the execution and quality of work.
   2. Deviations beyond allowable tolerances for pipe clearances.
D. Immediately remove all rejected materials from the project site.

3.2 INSTALLATION

A. General:
   1. Install in strict accordance with the pipe and fitting manufacturer's instructions and recommendations and as specified or as shown on the Drawings.
   2. Concrete thrust blocks or other acceptable thrust resistant system is required at all fittings on pressure pipe. Where thrust blocks are used, these shall be placed against undisturbed soil or screened gravel compacted to 95 percent and shall be placed so that the joints are accessible for repairs.
B. Assembling Joints:
   1. Push-on Joints:
      a. Insert the gasket into the groove of the bell.
      b. Uniformly apply a thin film of special lubricant over the inner surface of the gasket that will contact the spigot end of the pipe.
      c. Insert the chamfered end of the plain pipe into the gasket and push until it seats against the bottom of the socket.
   2. Bolted Joints:
      a. Remove rust preventive coatings from machined surfaces prior to assembly.
      b. Thoroughly clean and carefully smooth all burrs and other defects from pipe ends, sockets, sleeves, housings and gaskets.
      c. After jointing coat all bolts with bituminous material compatible with the pipe coating required herein and/or in Section 09900.

3. Flanged Joints:
   a. Insert the nuts and bolts (or studs), finger tighten, and progressively tighten diametrically opposite bolts uniformly around the flange to the proper tension.
   b. Execute care when tightening joints to prevent undue strain upon valves, pumps, and other equipment.
4. Mechanical Joints:
   a. Thoroughly clean, with a wire brush, surfaces that will be in contact with the gaskets.
   b. Lubricate the gasket, bell, and spigot by washing with soapy water.
   c. Slip the gland and gasket, in that order, over the spigot and insert the spigot into the bell until properly seated.
   d. Evenly seat the gasket in the bell at all points, center the spigot, and firmly press the gland against the gasket.
   e. Insert the bolts, install the nuts finger tight, and progressively tighten diametrically opposite nuts uniformly around the joint to the proper tension with a torque wrench.
   f. The correct range of torque (as indicated by a torque wrench) and the length of wrench (if not a torque wrench) shall not exceed:
      i. Range or Torque: 60-90 ft.-lbs.
      ii. Length of Wrench: l0 inches.
   g. If effective joint sealing is not attained at the maximum torque specified above, disassemble, thoroughly clean, and reassemble the joint. Do not overstress the bolts to tighten a leaking joint.
5. Bell and Spigot Joints:
   a. Thoroughly clean the bell and spigots and remove excess tar and other obstructions.
   b. Insert the spigot firmly into place and hold securely until the joint has been properly completed.

C. Fabrication:
1. Tapped Connections:
   a. Make all tapped connections as shown on the Drawings or as required by the Engineer.
   b. Make all connections watertight and of adequate strength to prevent pullout.
   c. Drill and tap normal to the longitudinal axis of the pipe.
   d. Taps in fittings shall be located where indicated by the manufacturer for that particular type of fitting.
   e. The maximum sizes of taps in pipes and fittings without busses shall not exceed the sizes listed in the appendix of ANS A2l.51 based on 2 full threads for ductile iron and 3 full threads for cast iron.
2. Cutting:
   a. Perform all cutting as set forth in AWWA C600.
   b. Carefully chamfer all cut ends to be used with push-on joints to prevent damage to gaskets when pipe is installed.

D. Pipe Deflection:
   1. Push-on and Mechanical Joints:
      a. The maximum permissible deflection of alignment at joints shall be limited to that given in AWWA C600.
   2. Flexible Joints:
      a. The maximum deflection in any direction shall not exceed the manufacturer's instructions and recommendations.

END OF SECTION

SECTION 02622

POLYVINYL CHLORIDE (PVC) NON-PRESSURE PIPE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:
   1. Provide and install PVC non-pressure pipe and fittings of the size(s) and type(s) and in the location(s) shown on the Drawings and as specified herein.

B. Related Work Specified Elsewhere: (When Applicable)
   1. Excavation and backfill, dewatering, pavement, borrow and bedding material, and cleaning and testing requirements are specified in the appropriate sections of this division.
   2. Pipe & Pipe Fittings - General is specified in Division 15.

1.2 QUALITY ASSURANCE

A. Manufacturers:
   1. Certain-Teed.
   2. J-M Manufacturing.
   3. Or equivalent.

1.3 SUBMITTALS TO THE ENGINEER

A. Submit shop drawings in accordance with the General Conditions of the Construction Contract.

B. Submit manufacturer's "Certification of Conformance" that pipe and fittings meet or exceed the requirements of these Specifications.

C. Submit other documents as specified in the appropriate Sections of this Division.

1.4 DELIVERY STORAGE AND HANDLING

A. Provide all labor necessary to assist the Engineer to inspect pipe, fittings, gaskets and other materials.

B. Carefully inspect all materials at the time of delivery and just prior to installation.

C. Carefully inspect all pipe and fittings for:
   1. Defects and damage
   2. Deviations beyond allowable tolerances for joint dimensions.
   3. Removal of debris and foreign matter.

D. Examine area and structures to receive piping for:
   1. Defects, such as weak structural components that adversely affect the execution and quality of work.
   2. Deviations beyond allowable tolerance for pipe clearances.

E. All materials and methods not meeting the requirements of the Contract Documents will be rejected.

F. Immediately remove all rejected materials from the project site.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Pipe and Fittings:
   1. The polyvinyl chloride pipe and fittings, including those required for stubs, shall conform to ASTM standard specification for PVC Sewer Pipe and Fittings, Designation D 3034 (SDR 35) (4" to 15"), F679 (18" to 27"), or F1760-01 (for recycled pipe, all diameters).
   2. Straight pipe shall be furnished in lengths of not more than 14 feet.
   3. Saddles will not be allowed.

B. Joints:
   1. Joints for the polyvinyl chloride pipe shall be push-on joints using factory installed elastomeric ring gaskets.
   2. The gaskets shall be securely fixed into place by the manufacturer so that they cannot be dislodged during joint assembly.
   3. The gaskets shall be of a composition and texture which is resistant to common ingredients of sewage and industrial wastes, including oils and ground water, and which will endure permanently under the conditions of the proposed use.
   4. The joints shall conform to ASTM Specifications for Joints for Drain and Sewer Plastic Pipes using Flexible Elastomeric Seals, Designation D3212-76.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Inspection:
   1. Each pipe unit shall be inspected before being installed. No single piece of pipe shall be laid unless it is generally straight.
   2. The centerline of the pipe shall not deviate from a straight line drawn between the centers of the openings at the ends of the pipe by more than 1/16 inch per foot of length.
   3. If a piece of pipe fails to meet this requirement for straightness it shall be rejected and removed from the site.
   4. Any pipe unit or fitting discovered to be defective either before or after installation shall be removed and replaced with a sound unit.

B. Jointing:
   1. All pipe and fittings shall be cleared of all debris, dirt, etc., before being installed and shall be kept clean until accepted in the completed work.
   2. Pipe and fittings shall be installed to the lines and grades indicated on the drawings or as required by the Engineer. Care shall be taken to ensure true alignments and gradients.
   3. All joint surfaces shall be cleaned. Immediately before jointing the pipe, the bell or groove shall be lubricated in accordance with the manufacturer's recommendation.

4. Each pipe unit shall than be carefully pushed into place without damage to pipe or gasket. Suitable devices shall be used to force the pipe units together so that they will fit with a minimum open recess inside and outside and have tightly sealed joints. Care shall be taken not to use such force as to wedge apart and split the bell or groove ends.
5. Joints shall not be "pulled" or "cramped" unless permitted by the Engineer.

C. Service Connections:
1. All service connections to new pipe shall utilize a wye fitting.
2. All service connections must enter the top half of the mainline pipe.
3. Service connections shall be 6-inch, minimum, unless otherwise noted.
4. Contractor shall provide all necessary fittings, adapters and couplings to connect the service to the sewer main.
5. Service laterals shall be placed at 2% slope, unless otherwise noted. If 2% slope is not available, notify the Engineer.
6. Contractor shall maintain the trench for sufficient time for the Engineer to inspect the work. Contractor shall provide 3 working day notice to the Engineer.

D. Pipe Deflection:
1. Pipe provided under this specification shall be installed so there is no more than a maximum deflection of 5.0 percent. Such deflection shall be computed by multiplying the amount of deflection (normal diameter less minimum diameter when measured) by 100 and dividing by the nominal diameter of the pipe.
2. The Contractor shall wait a minimum of 30 days after completion of a section of sewer, including placement and compaction of backfill, before measuring the amount of deflection by pulling a specially designed gage assembly through the completed section. The gage assembly shall be in accordance with the recommendations of the pipe manufacturer and be acceptable to the Engineer.
3. Should the installed pipe fail to meet this requirement, the Contractor shall do all work to correct the problem as the Engineer may require without additional compensation.

E. Testing:
1. Clean and test pipe in accordance with appropriate sections of this division.

END OF SECTION

SECTION 02628

HIGH DENSITY POLYETHYLENE PIPE AND FITTINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Furnish, install and test all polyethylene pipe, pipe fittings and appurtenances of the type(s) and size(s) and in the location(s) as shown on the Drawings and as herein specified.

B. Related Work Specified Elsewhere:
   1. "Earthwork" is specified in Section 02200.
   2. "Pipe and Pipe Fittings - General" is specified in Section 15050.

1.2 QUALITY ASSURANCE

A. Pressure rating or pressure class of pipe as shown on the Drawings or specified herein.

B. Standards:
   1. ANSI/AWWA C901-02: Standard for Polyethylene (PE) Pressure Pipe and Tubing, ½" (13 mm) through 3" (76 mm) for Water Service.
   2. AWWA C 906-99: Standard for Polyethylene (PE) Pressure Pipe and Fittings, 4" (100 mm) through 63" (1,575 mm) for Water Distribution and Transmission.
   3. ASTM D 2657-07: Standard Practice for Heat Joining Polyolefin Pipe and Fittings.
   4. ASTM D 2683-14: Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
   5. ASTM D 2837-13e1: Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
   6. ASTM D 3261-15: Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
   7. ASTM D 3350-14: Standard Specification for Polyethylene Plastic Pipe and Fittings Materials.
   8. ASTM F 1055-16: Standard Specification for Electrofusion type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and tubing.
   9. NSF/ANSI-61-2003e: Standard for Drinking Water Systems Components - Health Effects, NSF International, Ann Arbor, MI.
   10. CSA B 137.1-2002: Polyethylene Pipe, Tubing, and Fittings for Cold-Water Pressure Services.
   11. ASTM F2164, Standard Practice for Field Leak Testing of Polyethylene (PE) Piping Systems Using Hydrostatic Pressure.
   12. Manufacturers of high density polyethylene pipe, fittings, adapters, and couplings must be certified under ISO 9000, Quality Management Systems - Fundamentals and Vocabulary, International Organization for Standardization (ISO), Geneva, Switzerland.

13. 49 CFR 192 subpart F, 192.281, selected requirements for plastic joints; 192.282, requirements for qualifying joining procedures; 192.285, specifies qualifying persons to make joints; and 192.287, specifies inspection of joints.
14. Fusion Operators: Operators shall meet the minimum qualification requirements outlined in 49 CFR 192 subpart F, 192.285 and shall have documented experience with successful butt fusion of pipe larger than 24 inch diameter.
15. Joint Fusion Data: Fusion plate temperature (oF), interfacial fusion pressure (psi), interfacial contact fusion time (sec.), and cooling time (min.) shall be recorded by data logger for computer download or recorded by the operator(s) in a field book for each joint fusion completed.
16. Pipe deemed damaged or unacceptable to the Engineer shall be replaced at no additional cost to the Owner. Pipe shall be adequately protected during storage to prevent external damage to the pipe side wall or ends. Pipe with gouged side walls will be rejected by the Engineer.
17. Exterior pipe markings shall include the nominal pipe diameter, SDR, and rated working pressure.

C. Acceptable Pipe and Fitting Supplier/Manufacturers:
1. PolyPipe, Inc. "PW Pipe"
2. KWH Pipe, "Sclairpipe"
3. Performance Pipe
4. "Isco-Pipe"
5. "Poly-Cam"
6. "Friatec"
7. Vari-Tech "Performance Pipe"
8. Independent Pipe Products, Inc.
9. Or approved equal.

1.3 SUBMITTALS

A. Submit shop drawings in accordance with the applicable section of Division 1 and the General Conditions of the Construction Contract.
B. Submit manufacturer's "Certification of Conformance" that pipe and fittings and other piping appurtenances meet or exceed the requirements of these Specifications.
C. Submit experience statement for operator(s) to complete the pipe fusion to demonstrate the minimum experience and qualification requirements described in paragraph 1.2.B.14.
D. Following pipe construction, submit joint fusion data in an electronic spreadsheet format as a record to document joint fusion quality control.
E. Submit manufacturers installation instructions and specifications for all fittings, couplings, adapters, saddles, etc.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Pipes shall be either Iron Pipe Size (IPS) or Ductile Iron Pipe Size (DIPS) with SDR ratings as indicated in the pipe schedule.

B. Polyethylene compounds utilized in the manufacture of products furnished under this specification shall be listed in PPI TR-4, with a minimum cell classification of PE 445574C for PE 4710 materials, as defined in ASTM D3350. Pipe shall be in conformance with AWWA C901, AWWA C906, or CSA B137.1. They shall have a PPI recommended Hydrostatic Design Basis (HDB) of 1600 psi (PE4710) at a temperature of 73.4°F (23°C).

C. All materials which come in contact with water, including lubricants, shall be evaluated, tested and certified for conformance with NSF/ANSI Standard 61.

D. Clean re-work material of the same type grade, and cell classification generated from the manufacturer's own pipe and fitting production may be used by the same manufacturer as long as the pipe, tubing and fittings produced meet all the requirements of AWWA C901, AWWA C906, or CSA B137.1.

E. Pipe and tubing furnished under this specification shall be manufactured using compounds complying with the requirements above. Dimensional and performance characteristics shall conform to the requirements of AWWA C901, AWWA C906, or CSA B137.1.

F. The polyethylene compound shall be suitably protected against degradation by ultraviolet light by means of carbon black, well dispersed in a concentration of not less than 2%.

G. The polyethylene resin compound shall have a resistance to environmental stress cracking as determined by procedure detailed in ASTM D l693 with sample preparation by procedure C of ASTM D 4703 of not less than 40 hours.

H. Pipe shall be homogeneous throughout and free of visible cracks, holes, foreign material, blisters, or other deleterious faults.

I. Polyethylene fittings shall have the same pressure rating as the pipe itself for all pressurized pipeline applications.

J. Polyethylene fittings shall be molded style for diameters up to 12 inches and fabricated style for diameters larger than 12 inches.

2.2 PIPE SCHEDULE

PIPE IDENTIFICATION	DIA. (inches)	SDR	IPS/DIPS	WORKING PRESSURE RATING (PSI)	DE-BEAD REQUIRED INSIDE PIPE
Force Main	4	17	IPS	125	Yes

2.3 ADAPTERS AND COUPLINGS (AS APPLICABLE)

A. Polyethylene Mechanical Joint Adapter

1. For joining IPS or DIPS size polyethylene pipe to any ANSI\AWWA C153 ductile iron fitting and valve.
2. Molded from NSF listed PE 4710 resin.
3. Adaptor shall meet requirements of AWWA C901, 906.
4. Adaptor kit to include anchor fitting, epoxy coated ductile iron retainer gland ring, gasket, and long tee-bolts, and rubber gasket.
5. Provide stainless steel stiffeners as necessary.

B. Polyethylene Flanged Adapter
   1. For joining IPS or DIPS size polyethylene pipe to ANSI B16.1, ANSI B16.5, or ANSI A21.10 (AWWA C110) flange as required.
   2. Molded from NSF listed PE 4710 resin.
   3. Adaptor kit to include epoxy coated ductile iron backing ring, gasket, and long tee-bolts, and rubber gasket.
   4. Adaptor shall meet requirements of AWWA C901, 906.

C. Polyethylene Wall Anchor
   1. For restraining polyethylene pipe in cast-in-place concrete headwall.
   2. Molded from NSF listed PE 4710 resin.
   3. Pressure rating and size shall be the same as the required pipe and fitting SDR.
   4. IPS or DIPS to match required pipe size.

D. Polyethylene Electrofusion Coupling
   1. For joining plain ends of polyethylene pipe where butt fusion is not practical as approved by the Engineer.
   2. Molded from NSF listed PE 4710 resin or fabricated from pipe meeting NSF requirements with an integral heating element and electrical leads to connect the heating element power supply.
   3. Pressure rating and size shall be the same as the required pipe and fitting SDR.

E. Polyethylene Electrofusion Saddle
   1. For installation corporation stops in HDPE pipe for water service connection or manual air release valve.
   2. Molded from NSF listed PE 4710 resin with an integral heating element and electrical leads to connect the heating element power supply.
   3. Pressure rating and size shall be the same as the required pipe and fitting SDR.

F. Threaded HDPE Transition Adapter, Unions, and Threaded Adapters
   1. For joining polyethylene pipe to threaded fittings and valve ends (NPT.
   2. HDPE end of transition adapters be SDR rated to match required pipe SDR.
   3. HDPE end of transition adapters shall be molded from NSF listed PE 4710 resin.
   4. All metallic materials shall be constructed of Type 316 Stainless Steel.
   5. Coupling transition end shall be Male NPT.
   6. IPS or DIPS to match required pipe size.

G. Blind Flanges
   1. Molded from NSF listed PE 4710 resin.
   2. Pressure rating and size shall be the same as the required pipe and fitting SDR.

2.4 FABRICATION

A. Thermal Butt-Fusion:
   1. Join the pipe to itself, or to the polyethylene fittings or to the flange connections by means of thermal butt-fusion.
   2. Have all fusion performed by personnel trained by the pipe supplier or other qualified persons, using tools approved by the pipe supplier.
   3. The polyethylene fittings and flanged connections to be joined by thermal butt-fusion shall be from the same type, grade and class of polyethylene compound as the polyethylene pipe unless otherwise approved.

4. Joint strength must be equal to that of the adjacent pipe.

B. Socket Fusion (When Applicable)
   1. Join the pipe to socket type fittings by means of socket fusion
   2. Have all fusion performed by personnel trained by the pipe supplier or other qualified persons, using tools approved by the pipe supplier.
   3. The polyethylene fittings to be joined by thermal socket-fusion shall be from the same type, grade and class of polyethylene compound as the polyethylene pipe unless otherwise approved.

C. Electrofusion (When Applicable)
   1. Applies to the installation of electrofusion couplings and saddles.
   2. Have all fusion performed by personnel trained by the pipe supplier or other qualified persons, using tools approved by the pipe supplier.
   3. The coupling or saddle shall be joined using heat created by electric current from a control box.
   4. Install clamps to hold the fitting in place during the fusion process.

D. Flanged Joints
   1. Flange joining of sections of pipe is allowed to facilitate the pipe installation process as approved by the Engineer.
   2. Joints shall include full face gaskets.
   3. Flange bolts shall be tightened to the same torque valve and tightening pattern recommended by the manufacturer.
   4. Flange bolts and nuts shall be Type 316 stainless steel and have tensile strength equivalent to SEA Grade 3.
   5. Use flat Type 316 stainless steel washers between the nut and backup ring.
   6. Retighten bolts to the manufacturer recommended torque value after an hour to offset the effects of compression set.

E. Mechanical Connections: The mechanical connections of the polyethylene pipe to auxiliary equipment shall be in accordance with the pipe suppliers written instructions.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPES AND FITTINGS

A. Install joint and transition adapters in accordance with the manufactures recommendations.

B. Refer to the drawings and Section 02200 for additional bedding and backfill requirements.

C. Joining surfaces must be clean and dry.

D. Pipe must not be dumped, dropped, pushed or rolled into the trench. Provide appropriate equipment to lift move and lower the pipe into the trench as necessary.

E. Install pipe and fittings in accordance with the Marine Installations Chapter of PPI Handbook of Polyethylene Piping and C906 (4 in. to 63 in. diameter).

3.2 TESTING

A. Joint Quality

1. 12" diameter and smaller - On each day butt fusions are to be made, the first fusion of the day shall be a trial fusion. The trial fusion shall be allowed to cool completely, then fusion test straps shall be cut out. The test strap shall be 12" or 30 times the wall thickness in length (minimum) and 1" or 1.5 times the wall thickness in width (minimum). Bend the test strap until the ends of the strap touch. If the fusion fails at the joint, a new trial fusion shall be made, cooled completely and tested. Butt fusion of pipe to be installed shall not commence until a trial fusion has passed the bent strap test.
2. Pipes larger than 12" diameter - Visual inspection of the joint shall be the primary indicator of joint quality. Specific visual inspection criteria shall be provided by the pipe and fitting manufacturer. The v-groove between the bends shall be uniform around the circumference of the pipe and the both sides of the bead shall have uniform thickness and height indicating proper pipe alignment during the fusion process.
3. All fused joints shall be visually inspected by qualified fusion operators and the Engineer during construction to assure uniform alignment and beading.

B. Leak Test

1. Refer to Section 15050 for Testing.

END OF SECTION

SECTION 02641

GATE VALVES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Furnish, install and test gate valves of the type(s) and size(s) and in the location(s) shown on the Drawings and as specified.

B. Related Work Specified Elsewhere:
   1. "Ductile Iron Pipe & Fittings for Buried Applications" are specified in this Division.
   2. "Valves and Specialties - General" is specified in Division 15.
   3. "Gate Valves for Interior Applications" are specified in Division 15.

1.2 QUALITY ASSURANCE

A. All gate valves of same type and style shall be manufactured by one manufacturer.

B. Acceptable Manufacturers:
   1. American Flow Control
   2. Kennedy/McWane
   3. Clow/McWane
   4. Mueller
   5. Or approved equal.

1.3 SUBMITTALS

A. Submit shop drawings in accordance with the applicable section of Division 1 and the General Conditions of the Construction Contract.

B. Submit manufacturer's "Certification of Conformance" that valves meet or exceed the requirements of these Specifications.

C. Submit manufacturers installation instructions and specifications for all valves.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Waterworks type NRS valves (AWWA):
   1. Valve Body, bonnet and stuffing box - Cast iron (ASTM A126 C1B), or Ductile iron (ASTM A536), coated inside and out with fusion bonded epoxy meeting AWWA C550. Face-to-face dimensions shall comply with ANSI B16.10 and flanges to comply with ANSI B16.1.
   2. Resilient Wedge - Ductile iron wedge with bonded EPDM or Nitrile (Buna-N/NBR) rubber covering.
   3. Stem - Manganese bronze, ASTM B584
   4. Stuffing box O-rings
      a. Two O-rings, each nitrile rubber.
      b. Capable of changing under pressure.
   5. Wedgenut - Bronze, ASTM B62 or Manganese bronze, ASTM B584

6. Bolting - stainless steel Type 18-8 (304 SS), ASTM F593, GP1
7. End Connections
   a. Buried valves – gasketed and bolted mechanical joints in conformance with AWWA standards for appropriate pipe material.
   b. Exposed valves in buried structures – flanged and bolted joints in conformance with ANSI/ASME B16.1 and AWWA standards for appropriate pipe material. Bolts shall be stainless steel.
8. Operation
   a. Buried valves – 2-inch square nut, cast iron, ASTM A126, C1B or ductile iron, ASTM A536. Provide a sufficient of tee-handle valve wrenches for operation valves of various depths.
   b. Opening Direction –clockwise (open right)
9. Water working pressure: 250 psi
10. Standards - valves shall meet or exceed AWWA C509, latest edition.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install valves with stem position vertical.
B. Valve box vertical and centered over operating nut.
C. Valve box supported during backfilling and maintained vertical.
D. Install and test in accordance with AWWA C500 and AWWA C-509 or AWWA C515, latest revision.
E. For PVC or PE main, install anchor rods around the valve body or through the mounting lugs and embed the rods in concrete beneath the valve.

END OF SECTION

SECTION 02644

HYDRANT ASSEMBLIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Furnish and install hydrant assemblies of the type(s) and size (s) and in the locations (s) shown on the Drawings and as specified herein.

B. Hydrant Assemblies consist of:
   1. Hydrant anchoring tee, swivel tee or standard tee, as required.
   2. 6 inch gate valve and valve box.
   3. 6 inch hydrant branch piping.
   4. Hydrant.
   5. Drainage material.
   6. Thrust blocking and joint bracing.

C. Related Work Specified Elsewhere:
   1. Excavation and backfill, pavement, dewatering, borrow and bedding are specified in this Division.

1.2 QUALITY ASSURANCE

A. Hydrants shall conform to AWWA C502 and all hydrants shall be from one manufacturer.

B. Gate valves shall conform to AWWA C5090 (Resilient-Seated Gate Valves for Water Supply).

C. Acceptable Manufacturers:
   1. Mueller Company, Decatur, Illinois.
   2. Or approved equal.

1.3 SUBMITTALS

A. Submit shop drawings in accordance with the applicable section of Division 1 and the General Conditions of the Construction Contract.

B. Submit manufacturer's "Certification of Conformance" that all hydrant assemblies meet or exceed the requirements of these Specifications.

C. Submit manufacturers installation instructions and specifications for all hydrant assemblies.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Fire Hydrants:
   1. Dry barrel type with a 5 inch minimum valve opening.
   2. Two (2) 2-1/2 inch hose connections and one (1) 4-1/2 inch pumper connection.
      a. 2-1/2 inch outlets: 60o V threads, 7-1/2 threads to the inch, external threads 3-1/16 inches, O.D. National Standard threads.

b. 4-1/2 inch outlet: 4 threads to the inch, external threads 5-3/4 inches, O.D. National Standard threads.
c. Supply adapters if existing fire fighting equipment does not match the threads specified above.

3. 150 pounds working pressure and 300 pounds hydrostatic test pressure.
4. Working parts shall be bronze and open counterclockwise unless otherwise specified.
5. Designed with standpipe breaking ring or breakable sections.
6. Supply one (1) collision repair kit for every twenty-five (25) hydrants installed.
7. Caps shall be attached to hydrant body by chains.
8. Hydrants shall be self-draining type.

B. Gate Valves: Waterworks type non-rising stem AWWA valve as specified in the appropriate section of this Division.

C. Valve Boxes:
1. Cast iron, minimum thickness 3/10 inch with the word "WATER" cast in covers.
2. Be of such length as required without full extensions.
3. As specified in this Division.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install hydrants as shown in the details and using manufacturer's written instructions.
B. No hydrant assembly shall be backfilled until approved by the Engineer.
C. Provide drainage material and thrust blocks as shown.
D. Provide barrel extensions as required for hydrant to be installed at proper grade.
E. Provide finish paint on all exposed surfaces. Color shall meet Owner's requirements as approved by the Engineer.

3.2 CLEANING

A. Clean all hydrants of concrete, etc. and repaint as necessary to the satisfaction of the Engineer.

END OF SECTION

SECTION 02646

VALVE BOXES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Furnish and install valve boxes of type(s) and size(s) and in the locations shown on the Drawings and as specified herein.

1.2 QUALITY ASSURANCE

A. All valve boxes shall be manufactured by one manufacturer.

B. Qualifications of Manufacturer: Products to have been proven reliable in similar installations over a reasonable number of years.

C. Acceptable Manufacturers:

1. Tyler
2. Quality Water Products
3. Bibby-Ste-Croix
4. McWane
5. Or Equivalent

1.3 SUBMITTALS

A. Submit shop drawings in accordance with the applicable section of Division 1 and the General Conditions of the Construction Contract.

B. Submit manufacturer's "Certification of Conformance" that all valve boxes meet or exceed the requirements of these Specifications.

C. Submit manufacturers installation instructions and specifications for all valve boxes.

PART 2 - PRODUCTS

2.1 MATERIALS

A. The valve box shall be ductile iron or cast iron, slip type two-piece integral base, 5-1/4 inch shaft. Top section with flanges.

B. The cover shall be ductile iron or cast iron, with the word "Water" or "Sewer" cast in cover.

C. Belled Base Section.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation as shown on the Drawings and/or as specified herein.
   1. When installation is complete, no pressure shall be exerted by valve box on the water main or on the valve.
   2. Be of such length as required without full extension. Minimum lap 6 inches.

END OF SECTION

SECTION 02650

BURIED UTILITY MARKINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:
   1. This work shall consist of providing and installing utility line markings above all buried lines installed as part of this contract and replacing existing markings disturbed as part of this contract. Buried utilities are indicated on the Civil and Electrical Drawings.

B. Related Work Specified Elsewhere:
   1. Pipe, excavation, backfill, insulation are specified in the appropriate Sections in this Division.

1.2 SUBMITTALS

A. Submit shop drawings in accordance with the applicable section of Division 1 and the General Conditions of the Construction Contract.

B. Submit manufacturer's "Certification of Conformance" that utility markings meet or exceed the requirements of these Specifications.

C. Submit manufacturers specifications for utility markings.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials and color shall be in accordance with latest AASHTO specifications for pipe and utility marking.

B. Marking tape color shall be in accordance with latest American Public Works Association (APWA) Uniform Color Code and American National Standards Institute ANSI Standard Z535.1, Safety Color Code specifications for buried utility marking as noted in the Schedule below.
   1. Schedule

Marker Color	Buried Utility
Blue	Potable Water &Associated lines
Green	Sanitary Sewers, Storm Drain and other Drain lines
Orange	Telecommunication, signal, alarm
Purple	Reclaimed, Recycled, Irrigation Water and Slurry Lines
Red	Electric Power lines cables conduits and lighting cables
Yellow	Gas, Oil, Steam, Petroleum or Gaseous Material Lines

   2. Warning Information shall be in Black Letters with typical wording of:
      a. "CAUTION: BURIED (NAME OF UTILITY LINE) BELOW"

C. For ferrous pipe material use 0.004" minimum polyethylene film; 6" wide clearly marking type of buried utility.
D. For non-ferrous pipe material (e.g. Concrete, PVC, PE, etc.) use detection tape composite of polyethylene and metallic core 6" wide clearly marking type of buried utility.
E. Seton Identification Products, New Haven, CT, Utility Safeguard LLC or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Marking tape shall be installed over utility lines centerline and buried 24" below grade.
B. Markings damaged during opening of trench shall be reinstalled with 2' overlap at broken sections.

END OF SECTION

SECTION 02655

COUPLINGS & CONNECTORS FOR BURIED APPLICATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Furnish and install couplings and connectors of the type and size in the location shown on the Drawings and as specified herein.

1.2 QUALITY ASSURANCE

A. Minimum pressure rating equal to that of the pipeline in which they are to be installed.

B. Couplings and connectors, other than those specified herein, are subject to the Engineer's approval. Acceptable Manufacturers:
   1. Romac Industries
   2. Krausz
   3. Smith Blair
   4. For Meter Box Company
   5. Or Equal

C. Reference Standards:
   1. AWWA C104 – Cement-Mortar Lining for Ductile-Iron Pipe and Fittings
   2. AWWA C111 – Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
   3. AWWA C116 – Protective Fusion-Bonded Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings
   4. AWWA C153 – Ductile-Iron Compact Fittings
   5. AWWA C213 – Fusion-Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings
   6. AWWA C219 – Bolted, Sleeve-Type Couplings for Plain-End Pipe

1.3 SUBMITTALS

A. Submit shop drawings in accordance with the applicable section of Division 1 and the General Conditions of the Construction Contract.

B. Submit manufacturers product data and installation instructions.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All Couplings and Connectors:
   1. Gasket Materials: Composition suitable for exposure to the liquids to be contained within the pipes.
   2. Diameters to properly fit the specific types of pipes on which couplings and connectors are to be installed.

B. Sleeve Type Transition Couplings (for 4 – 12” pipe size)
   1. Buried Non-Restrained Couplings:
      a. Two top facing bolt design
      b. Fusion bonded epoxy ductile iron center sleeve, end rings and bolt guides. Ductile iron meeting or exceeding ASTM A536, Grade 65-45-12.
      c. Two wedge-section EPDM or NBR rubber gaskets compounded for water service. NSF-61 certified for potable water service.
      d. Ductile iron heat treated grippers, 304 stainless steel draw hooks, and reinforced nylon ramp runners.
      e. Nuts and bolts shall be 304 Stainless Steel with rolled thread and anti-galling compound.
      f. Couplings shall be long barrel type.
      g. Coupling shall be fusion bonded epoxy coated meeting AWWA C213 and NSF-61 standards for potable water applications.
      h. Acceptable Manufacturers:
         i. Romac Industries – Macro HP™
         ii. Krausz – Hymax® 2
         iii. Smith Blair – Model 421
         iv. Or Equal
   2. Buried Restrained Couplings:
      a. Two top facing bolt design
      b. Fusion bonded epoxy steel or ductile iron center sleeve and end rings.
      c. Two wedge-section EPDM or NBR rubber gaskets compounded for water service and NSF-61 certified.
      d. 304 Stainless Steel bridge or Armor over gasket in expansion zone.
      e. Nuts and bolts shall be 304 Stainless Steel with rolled thread and anti-galling compound.
      f. Couplings shall be long barrel type.
      g. Coupling shall be fusion bonded epoxy coated meeting AWWA C213 and NSF-61 standards for potable water applications
      h. Acceptable Manufacturers:
         i. Romac Industries – Alpha™
         ii. Krausz – Hymax Grip
         iii. Smith Blair – Pipe Lock Coupling
         iv. Or Equal

C. Solid Sleeve Couplings
   1. Solid sleeves shall be ductile iron with mechanical joint ends.
   2. Couplings shall meet AWWA/ANSI C-153/A21.53 and C-111/A21.11 for joints, and C-104/A21.4 for cement lining in sizes 3"-24".
   3. Nuts and bolts shall be ductile iron low alloy steel per ANSI/AWWA A21.11/C-111.

4. Acceptable Manufacturers:
    a. Romac – Model 501
    b. Smith Blair – Model 441.
    c. Ford – Model FC1 or FC2A
    d. Or Equal

D. Flexible Couplings for drain connections (Fernco or equal)
1. Rubber material with stainless steel clamps
2. Must provide a positive seal against infiltration and exfiltration
3. Coupling materials must conform to applicable portions of ASTM C443 (Concrete), C564 (Cast Iron), D1869 (A.C.), D5926 (PVC), C1173 (transition) and CSA B602.

E. Mechanical Joint Adaptors (Foster Adaptor® – Infact Corporation)
1. Required to connect fittings and valves with mechanical joints
2. Ductile iron construction mechanical joint bolt pattern.
3. Bolts and nuts shall meet AWWA C-111.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Sleeve Type Couplings:
1. Thoroughly clean pipe ends a minimum of 12-inches from the ends prior to installing couplings and use soapy water as a gasket lubricant.
2. Slip an end ring and gasket over each pipe and place the center sleeve centered over the joint.
3. Insert the other pipe length into the center sleeve the proper distance.
4. Press the gaskets and end rings evenly and firmly into the center sleeve flares.
5. For two-bolt systems, insert or tighten the bolts, finger tighten and progressively tighten nuts on the top of the coupling with a torque wrench applying the torque recommended by the manufacturer. For multiple bolt systems, insert or tighten the bolts, finger tighten and progressively tighten diametrically opposite nuts around the coupling with a torque wrench applying the torque recommended by the manufacturer.
6. Insert and tighten the tapered threaded lock pins as needed.

B. Install thrust rods, supports, and other provisions to properly support pipe weight and axial equipment loads.

END OF SECTION

SECTION 02751

SEWER FLOW CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: During the installation, replacement, rehabilitation and/or testing of sanitary sewer lines and sanitary sewer manholes via open-cut or trenchless approach, the Contractor shall maintain and control flow around the pipe segment(s) or structure(s) that are temporarily out of service. Existing sewer services shall remain live at all times during the progress of the Work. All temporary pumping equipment shall meet the requirements outlined in local noise regulations.

B. Additional Requirements Specified Elsewhere:
   1. Summary of Work: Section 01010
   2. Submittals: Section 01340
   3. Sewer Line Cleaning: Section 02752
   4. Final Sewer Testing: Section 02755

1.2 SUBMITTALS

A. In accordance with the requirements of Section 01340. Additional specific information required is listed below.
   1. Proposed schedule, sequence of construction, duration of activities and description of sewer control methods to be utilized for each element of the project.
   2. Technical data (including capacity and fuel tank size) of any portable temporary pumping equipment to be used during normal Contractor work hours.
   3. Supplemental information required under Section 01515 for sewer flow control which extends beyond Contractor work hours.

PART 2 - PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION

3.1 COORDINATION OF WORK

A. Provide all labor and equipment necessary to coordinate work of this section and maintain communications.

B. Notify all personnel, including but not limited to the Owner, Engineer, and Utility Companies seven days in advance of any temporary bypass pumping work. The Owner will identify personnel to be notified in addition to those identified by the Contractor.

C. Contractor shall coordinate temporary bypass pumping operations with the Owner and Engineer on a daily basis.

3.2 PERFORMANCE

A. General
   1. The Contractor shall install and test all sewer flow control methods to the satisfaction of the Owner and Engineer prior to proceeding with the Work.
   2. The Contractor shall be solely responsible for clean-up, repair, property damage costs and claims resulting from failure of the diversion system.

B. Plugging or Blocking:
   1. Insert plug at a manhole upstream of line to be inspected and tested.
   2. Plug shall be so designed that all or any portion of the sewage flows can be released.
   3. Flows shall be shut off or substantially reduced during line testing.

C. Pumping and Bypassing:
   1. When required, supply the necessary pumps, conduits and other equipment (including standby equipment) to divert the flow of sewage around the line in which work is being performed.
   2. Furnish the necessary labor and 24-hour supervision to set up, test and operate the pumping and bypassing system.
   3. Any temporary pumps, piping, fuel storage, or other appurtenances associated with the portable temporary pumping equipment shall be either located above the 100-year flood elevation or protected against flotation or other damage which would be caused by a flood event.

END OF SECTION

SECTION 02752

SEWER LINE CLEANING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Provide all equipment necessary for the proper cleaning of the sewers prior to the joint testing operations and/or closed circuit television inspection.

B. Related Work Specified Elsewhere: Sewer line joint testing and closed circuit television inspection are specified in this Division.

PART 2 - PRODUCTS

2.1 MATERIALS

A. High Velocity Hydro-Cleaning Equipment shall:

1. Have a minimum of 400 feet of high pressure hose.
2. Have multiple high velocity nozzles, as follows:
   a. Standard 35 degree nozzle with multiple rear jets and one front jet.
   b. Sand nozzle capable of transporting sand and gravel to the downstream manhole; and
   c. Rotating nozzle for removal of grease and scale.
3. Include a high velocity gun for washing and scouring manhole walls and floor.
4. Be capable of producing flows from a fine spray to a long distance solid stream.
5. Include a water tank, auxiliary engines and pumps, and a hydraulically driven hose reel.
6. Have equipment operating controls located above ground.

PART 3 - EXECUTION

3.1 PERFORMANCE

A. Select cleaning equipment based on the conditions of the lines at the time the work commences.

1. Light cleaning (small amounts of debris exist within the sewer line): Use high pressure water jetting equipment, brushes and swabs.
2. Heavy cleaning (large deposits of debris or heavy root growth exist within the sewer line): Use high pressure water jetting equipment specifically designed for the intended use.

B. Use selected equipment to remove all dirt, grease, rock and other deleterious materials and obstructions.

C. Protect existing sewer lines from damage caused by improper use of cleaning equipment.

D. Take precautions to avoid damage or flooding to public or private property being served by the line being cleaned.

E. Removal of Materials:

1. Remove all solids and semi-solids at the downstream manhole of the section being cleaned.
2. Passing material from one section of a line to another will not be permitted.

F. Disposal of Materials: Remove from the site and dispose of all solids or other waste materials recovered during the cleaning operations in an approved manner.

3.2 FIELD QUALITY CONTROL

A. Acceptance of this portion of the work may be made upon completion of subsequent television inspection and shall be to the complete satisfaction of the Engineer.

END OF SECTION

SECTION 02755

FINAL SEWER TESTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:

1. Final sewer testing work includes the performance of testing and inspecting each and every length of sewer pipe, pipe joints and each item of appurtenant construction.
2. Perform testing at a time acceptable to the Engineer, which may be during the construction operations, after completion of a substantial and convenient section of the work, or after the completion of all pipe laying operations.
3. Provide all labor, pumps, pipe, connections, gages, measuring devices and all other necessary apparatus to conduct tests.

B. Related Work Specified Elsewhere (When Applicable):

1. Excavation, backfill, dewatering, pipe, pipe fittings and manholes are specified in the appropriate Sections in this Division and/or Division 15.
2. Manhole testing is specified in Section 02601 - Manholes, Covers and Frames.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.1 PERFORMANCE

A. General:

1. All sewers, manholes, and appurtenant work, in order to be eligible for acceptance by the Engineer, shall be subjected to tests that will determine the degree of watertightness and horizontal and vertical alignment.
2. Thoroughly clean and/or flush all sewer lines to be tested, in a manner and to the extent acceptable to the Engineer, prior to initiating test procedures.
3. Perform all tests and inspections in the presence of the Engineer and the plumbing or building inspector in accordance with the requirements of the local and state plumbing codes.
4. Perform testing by test patterns determined by or acceptable to the Engineer.
5. Remedial Work:
   a. Perform all work necessary to correct deficiencies discovered as a result of testing and/or inspections.
   b. Completely retest all portions of the original construction on which remedial work has been performed.
   c. Perform all remedial work and retesting in a manner and at a time acceptable to by the Engineer at no additional cost to the Owner.

B. Line Acceptance Tests (Gravity sewers with no active service connections):
   1. Test all gravity sewer lines with no active service connections for leakage by conducting a low pressure air test.
   2. Equipment:
      a. Pneumatic plugs shall have a sealing length equal to or greater than the diameter of the pipe to be inspected.
      b. Pneumatic plugs shall resist internal test pressures without requiring external bracing or blocking.
      c. All air used shall pass through a single central panel.
      d. Connect 3 individual hoses:
         i. From the control panel to the pneumatic plugs for inflation.
         ii. From the control panel to the sealed sewer line for introducing the low pressure air.
         iii. From the sealed sewer line to the control panel for continually monitoring the air pressure rise in the sealed line.
   3. Testing Pneumatic Plugs:
      a. Seal test all pneumatic plugs prior to using them in the actual test.
      b. Lay one length of pipe on the ground and seal both ends with the pneumatic plugs to be tested.
      c. Pressurize the sealed pipe to 5 psig.
      d. The pneumatic plugs are acceptable if they remain in place without bracing.
   4. Testing Sewer Pipeline:
      a. After the sewer pipe has been cleaned and the pneumatic plugs checked, place the plugs in the sewer line at each manhole and inflate them.
      b. Introduce low pressure air into the sealed sewer pipeline until the air pressure reaches 4 psig greater than the average groundwater pressure.
      c. Allow a minimum of 2 minutes for the air pressure to stabilize to a minimum of 3.5 psig greater than the groundwater pressure. Groundwater is assumed to be at ground surface unless the Contractor can prove by otherwise by test pitting.
      d. After the stabilization period, disconnect the air hose from the control panel to the air supply.

e. The pipeline will be acceptable if the pressure decrease is not greater than l/2 psig in the time stated in the following table for the length of pipe being tested:

Pipe Diameter (inches)	Time (Min.) for Length of Pipe 0-100 ft	101-200 ft	201-300 ft	301-400 ft
4	2.0	2.0	2.0	2.0
6	3.0	3.0	3.0	3.0
8	4.0	4.0	4.0	5.0
10	5.0	5.0	6.0	8.0
12	5.5	5.5	8.5	11.5
15	7.0	8.5	13.0	17.0
18	8.5	12.0	19.0	25.0
21	10.0	17.5	26.0	35.0
24	11.5	23.0	34.0	45.5
27 and larger	14.5	29	43.0	58.0

5. Test Results:
   a. If the installation fails the low pressure air test, determine the source of leakage.
   b. Repair or replace all defective materials and/or workmanship and repeat low pressure air test at no additional cost to the Owner.

C. Line Acceptance Tests (Gravity sewers with active services):
1. Test all new gravity sewer lines with active services by conducting a low-pressure air test on all joints using a packer after all services have been connected or capped at the property line and all trenches backfilled but before the surface course of permanent pavement is installed.
2. Equipment:
   a. Closed-circuit television system.
   b. Testing devices (packer):
      i. Capable of isolating individual joints by creating a sealed void space around the joint being tested.
      ii. Constructed such that low pressure air can be admitted into the void area.
      iii. Shall contain a pressure gauge accurate to one tenth (0.1) psi in-line with the feed line to monitor the void pressure.
      iv. Capable of performing in sewer lines where flows do not exceed 1/4 of the pipe diameter without resorting to any method of flow control.
3. Testing Sewer Pipeline Joints:
   a. Test all joints except those with visible infiltration.
   b. Procedure:
      i. Pull television camera through sewer line in front of the packer.
      ii. Position the packer on each joint to be tested.
      iii. Inflate the sleeves on each end of the packer.

iv. Apply four (4.0) psi pressure above the existing hydrostatic pressure on the outside of the joint to the void area created around the inside perimeter of the joint.
v. Shut off the supply of air once the pressure has stabilized at the required amount.
vi. Monitor the void pressure for thirty (30) seconds.
vii. Repair the joint if the pressure drops more than one half (1/2) psi in the thirty (30) seconds.

c. Water or chemical pressure testing may be used in lieu of air testing subject to review and approval by the Engineer.
d. Re-clean and re-inspect all lines not approved by the Engineer at no additional cost to the Owner.
e. Repairing of Joints:
i. When a joint fails the pressure test, excavate and repair the failed joint. Repairing joints with chemical grout will not be permitted.
f. The Engineer may request checking of the testing equipment for accuracy.
i. Perform standard air test on a clean continuous section of pipe.
ii. Repair the equipment if the void pressure drops.
g. Testing Operation Inspection:
i. Reset each joint, as specified herein, prior to acceptance and final payment for joint testing. Retest all joints that fail until the test requirements are met.
h. The contractor will supply a black and white photograph of every joint that fails the pressure test.

D. Alignment Tests (Gravity Sewers):
1. Perform tests for the correctness of horizontal and vertical alignment on each and every length of gravity sewer pipeline between manholes.
2. Alignment tests to be conducted after all pipe has been installed and backfilled.
3. The observation test shall be conducted after all upstream work has been completed and the pipeline cleaned of debris.
4. Notify the Engineer at least 24 hours in advance of the proposed observation testing.
5. Introduce water into the sewer lines to be tested from the upstream manhole prior to the observation test but no more than 24 hours in advance of the test.
6. Beam a source of light, acceptable to the Engineer, through the pipeline from both ends and the Engineer will directly observe the light in the downstream, and/or upstream manhole of each test section.
7. The length of pipe between manholes, diameter of pipe and amount of light observed in the manhole at the end of each pipe section will determine acceptance of the alignment test by the Engineer.
8. The amount of vertical and horizontal deflection shall not be greater than the ASTM allowance and (manufacturer's recommendations) for the pipe being tested.
9. No standing water shall be allowed. The presence of standing water shall be cause for rejection of that pipe (including manhole) section.

10. Improper alignment will be corrected by re-excavation and resetting of pipe at no additional cost to the Owner.

E. Pipe Deflection: (Gravity Sewers)
   1. Pipe provided under this specification shall be installed so there is no more than a maximum deflection of 5.0 percent. Such deflection shall be computed by multiplying the amount of deflection (normal diameter less minimum diameter when measured) by 100 and dividing by the nominal diameter of the pipe.
   2. The Contractor shall wait a minimum of 30 days after completion of a section of sewer, including placement and compaction of backfill, before measuring the amount of deflection by pulling a specially designed gage assembly through the completed section. The gage assembly shall be in accordance with the recommendations of the pipe manufacturer and be acceptable to the Engineer.
   3. Should the installed pipe fail to meet this requirement, the Contractor shall do all work to correct the problem as the Engineer may require without additional compensation.

F. Inspection of Appurtenant Installations:
   1. Completely inspect, at a time determined by the Engineer, all manholes and inlets to ascertain their compliance with the Drawings and Specifications.
   2. Provide access to each manhole and inlet and check the following characteristics:
      a. Shape and finish of invert channels,
      b. Watertightness and finish of masonry structures,
      c. Location, type, and attachment of stops,
      d. Elevation and attachment of frames, covers, and openings,
      e. Pattern and machining of covers, and
      f. Drop connection arrangements.

G. Testing Pressure Sewers:
   1. The section of pipe to be tested shall be filled with water of approved quality, and all air shall be expelled from the pipe. If blowoffs are not available at high points for releasing air, the Contractor shall make the necessary excavations backfilling and taps at such points and shall plug said holes after completion of the test.
   2. The section under test shall be maintained full of water for a period of 24 hours prior to the combined pressure and leakage test being applied.
   3. Perform pressure and leakage test at 1-½ times the maximum system pressure or 100 psi whichever is greater (based on the elevation of the lowest point of the section under test and corrected to the gage location). Test duration shall be two hours.

4. While maintaining this pressure, the Contractor shall make a leakage test by metering the flow of water into the pipe. Leakage, if any, shall be equal to or less than the amounts as determined by Section 4.2 of AWWA C 600.

$$L = \frac{SD\sqrt{P}}{148{,}000}$$

L = allowable leakage in gallons per hour
S = length of pipe tested, in feet
D = nominal diameter of pipe, in inches
P = average test pressure, in pounds per square inch

5. In addition to meeting the leakage testing above, all joints within chambers and all flanged joints shall have no visible leakage.
6. If the section fails to pass the pressure and leakage test, the Contractor shall do everything necessary to locate, uncover, and repair or replace the defective pipe, fitting, or joint, all at his own expense and without extension of time for completion of the work. Additional tests and repairs shall be made until the section passes the specified test.

H. Manhole Leakage Testing:
1. Specified in the "Manholes, Covers and Frames" Section in Division 2.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Cast-In-Place Concrete indicated on the Contract Drawings
B. Formwork
C. Concrete deformed reinforcement bars and accessories
D. Waterstops
E. Epoxy anchorage of reinforcement
F. Epoxy and expansion anchors are specified herein but shall be provided and installed under the specification sections wherein the items requiring such anchors are specified.

1.2 PRODUCTS INSTALLED BUT FURNISHED UNDER OTHER SECTIONS

A.	Anchor Rods	Section 05500 - Metal Fabrications
B.	Curb Bar	Section 05500 - Metal Fabrications
C.	Pipe Sleeves	Section 15092 - Pipe Sleeves and Seals
D.	Conduit	Division 16

1.3 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Vertical and horizontal deformed masonry reinforcement excluding dowels embedded in concrete - Section 04200 - Unit Masonry.

1.4 RELATED SECTIONS

A. Section 01340 - Submittals
B. Section 01400 - Quality Control
C. Section 03305 - Concrete Testing
D. Section 03346 - Concrete Finishing and Curing
E. Section 05500 – Metal Fabrications
F. Section 07100 - Waterproofing
G. Section 15092 - Pipe Sleeves and Seals
H. Section 16050 - Basic Materials and Methods

1.5 REFERENCES

A. This section contains references that are applicable to this Specification Section. The applicable edition of the indicated references shall be the version that was the most current at the time of the Advertisement of Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued, or replaced.

B. AASHTO T 26 – Standard Method of Test for Quality of Water to Be Used in Concrete
C. ACI 117 – Specifications for Tolerances for Concrete Construction and Materials
D. ACI 301 - Specifications for Structural Concrete
E. ACI 306.1 – Standard Specification for Cold Weather Concreting
F. ACI 306R – Guide to Cold Weather Concreting
G. ACI 318 - Building Code Requirements for Structural Concrete and Commentary
H. ACI 355.4 – Qualifications of Post-Installed Adhesive Anchors in Concrete
I. ACI SP-66 – ACI Detailing Manual
J. ASTM A615/A615M – Standard Specification for Deformed and Plain Billet - Steel Bars for Concrete Reinforcement
K. ASTM C33/C33M – Standard Specification for Concrete Aggregates
L. ASTM C40/C40M – Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
M. ASTM C87/C87M – Standard Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
N. ASTM C88 – Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
O. ASTM C94/C94M – Standard Specification for Ready Mixed Concrete
P. ASTM C114 – Standard Test Methods for Chemical Analysis of Hydraulic Cement
Q. ASTM C131/C131M – Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Abrasion Machine
R. ASTM C150/C150M – Standard Specification for Portland Cement
S. ASTM C260/C260M – Standard Specification for Air Entraining Admixtures for Concrete
T. ASTM C494/C494M – Standard Specification for Chemical Admixtures for Concrete
U. ASTM C535 – Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Abrasion Machine
V. ASTM C595/C595M – Standard Specification for Blended Hydraulic Cements
W. ASTM C618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
X. ASTM C989/C989M – Standard Specification for Slag Cement for Use in Concrete and Mortars
Y. ASTM C1240 – Standard Specification for Silica Fume Used in Cementitious Mixtures
Z. ASTM C1260 – Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
AA. ASTM C1293 – Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction
BB. ASTM C1567 – Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar Bar Method)
CC. ASTM C1602/C1602M – Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
DD. ASTM C1603 – Standard Test Method for Measurement of Solids in Water

EE. ASTM C1778 – Standard Guide for Reducing the Risk of Deleterious Alkali-Aggregate Reaction in Concrete
FF. ASTM D516 – Standard Test Method for Sulfate Ion in Water
GG. ASTM E329 – Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction
HH. Concrete Reinforcing Steel Institute – 10MSP, Manual of Standard Practice
II. Concrete Reinforcing Steel Institute - Placing Reinforcing Bars
JJ. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements

1.6 QUALITY ASSURANCE

A. Perform work in accordance with ACI 301, ACI 117 and ACI 306.1 as modified here-in.
B. Expansion and epoxy anchors shall meet the following requirements:
    1. Epoxy anchors shall be qualified for earthquake loading (use in cracked concrete) in accordance with ACI 355.4.
    2. Epoxy anchors installed shall be qualified in accordance with ACI 355.4 requirements for sensitivity to installation direction.
    3. Epoxy anchors shall be installed by personnel certified by an applicable certification program that includes written and performance tests in accordance with ACI/CRSI Adhesive Anchor Installation Certification program

1.7 SUBMITTALS

A. Submit shop drawings for concrete reinforcement prior to fabrication, showing bar bends, details and placement and certified copies of Mill Test Reports for the reinforcement. Conform to ACI SP-66. Details shall include:
    1. Sizes, dimensions, and locations for reinforcement and supports
    2. Bending diagrams and schedules
    3. Splices
    4. Dowel Bar Splicers and Mechanical Bar Splicers: product data including strength tests
    5. Cover and clearances
    6. Class designation and details for bar supports
    7. Pertinent reinforced concrete details with dimensions and elevations
    8. Embedded items furnished by other trades and/or under other sections of the specification that are to be cast in concrete where interference with reinforcement may occur
    9. Show reinforcement on: Plan views of slabs, wall elevations and sections, beam elevations and details. Provide plan details at wall intersections and openings.
B. Submit Concrete Mixture designs including field performance and/or laboratory test results which meet the criteria specified in ACI 301, Section 4. Mixture design shall include:
    1. Proportions for all ingredients, 28-day design compressive strength, water to cementitious materials ratio, admixture dosages, slump, air content and density.
    2. Cement Manufacturer's Certificates of conformance with ASTM C150/C150M or C595/C595M taken during the last 90 days.

3. Supplementary Cementitious Materials: Source and test reports with certificates of conformance with ASTM C618 for fly ash and ASTM C989/989M for slag cement for actual material to be used in the Work taken during the last 90 days
4. Aggregate: data not older than 90 days, except test data for soundness, abrasion, alkali reactivity – not older than 12 months. Fine and coarse aggregate data and test results shall include:
    a. Sources
    b. Specific Gravity
    c. Sieve analyses per ASTM C33/C33M, including fineness modulus of fine aggregate
    d. Organic impurities per ASTM C40/C40M (fine aggregate).
    e. Aggregate reactivity (fine and coarse aggregate), one of the following options:
        i. Aggregate test data in accordance with ASTM C1293,
        ii. Concrete mixture tests in accordance with ASTM C1567,
        iii. Categorized in accordance with ASTM C1778 with testing in accordance with ASTM C1293 at 1-year, or ASTM C1260 at 16-days if ASTM C1293 test data is not available. Also indicate the total alkali loading contributed by portland cement in the submitted mixture/s.
    f. Soundness per ASTM C88 tested with magnesium sulfate (fine and coarse aggregate).
    g. Abrasion per ASTM C131/C131M or ASTM C535 (coarse aggregate).
5. Product data and material safety data sheets for concrete admixtures.
6. Test reports by testing agencies meeting ASTM E329:
    a. Field test data used to determine the standard deviation used for establishing the required average design strength, and field test data documenting that the proposed concrete proportions will produce an average compressive strength equal or greater than the required average compressive strength, shall be from within the previous 12 months.
    b. Laboratory trial batch data shall be from with the previous 12 months.

C. Submit product data and material safety data sheets for concrete accessories.

D. Submit sample concrete mixture delivery slip that shall include the following information:
1. Serial number of ticket
2. Date and project location
3. Name and location of ready mixed concrete plant
4. Truck number, time loaded, cubic yards delivered
5. Mixture design
6. Quantities of admixtures, with brand names
7. Quantities and types of cement, fly ash and/or slag
8. Quantity of water including quantity of water withheld
9. Quantities of fine and coarse aggregate including moisture content, nominal maximum aggregate size
10. Quantity of water added subsequent to plant batching
11. Unloading time and location

E. Submit product data and material safety data sheets for form release agent.
F. Submit product data for epoxy adhesive anchors. Data shall include:
    1. Material properties of anchors and epoxy adhesive
    2. ICC-ES AC308 report
    3. Allowable and ultimate loads of the anchor system
    4. Storage requirements
    5. Installation requirements including:
        a. Drilling method (diamond drill bit shall be prohibited)
        b. Drill bit diameter and depth of hole for each size anchor
        c. Hole cleaning procedure and required condition of hole
        d. Requirements for discarding initial discharge to ensure proper mixing
        e. Hole filling procedure
        f. Time period when anchor cannot be contacted or otherwise disturbed
        g. Gel and cure times as a function of temperature
        h. Installation temperature requirements for cartridges and base material
G. Submit product data for form ties.
H. Submit product data with strength tests for dowel bar and mechanical bar splicers.
I. For conduit to be encased in concrete structures submit a conduit layout plan under Section 16050. The conduit layout plan shall be reviewed with no exceptions taken by the Engineer prior to submission of reinforcement shop drawings.
J. Submit methods to be used to protect the concrete during cold weather placements, as defined in Section 03346. The Engineer's review shall be for information only as the Contractor is responsible for the means and methods of protection of concrete placed during cold weather.
K. Submit methods to be used to protect the concrete during hot weather placements. The Engineer's review shall be for information only as the Contractor is responsible for the means and methods of protection of concrete placed during hot weather.

1.8 PRE-CONCRETE MEETING

A. Engineer shall hold meeting after the concrete mixture design has been reviewed by the Engineer and more than 14 days prior to the first concrete placement to review concrete procedures.
B. Meeting Minutes: Engineer shall record minutes of meeting and distribute to attending parties, within 10 business days of meeting.
C. Attendance: General Contractor shall coordinate the attendance of the following parties: Contractor; concrete supplier; concrete subcontractor; admixture manufacturer and concrete pumping contractor. Engineer shall coordinate the attendance of the following parties: Structural Engineer, Independent Testing Laboratory and Engineer's Resident Project Representative.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Undamaged smooth form facing materials such as plywood, hardboard, metal and plastic that will produce a smooth form finish with fins and offsets not exceeding 1/8 inch. Surfaces shall be clean, free of scratches, mars and discolorations. The Engineer may reject formwork the Engineer deems to be unacceptable or that may produce

concrete that will not meet the specified requirements including surface finish.

B. Steel: Minimum 16 ga. sheet, well matched, tight fitting, stiffened to resist loads without excess deflection.

C. Aluminum: Forms with unoxidized surfaces shall be pretreated with a calcium hydroxide and water paste followed by repeated water rinsing until hydrogen bubbles no longer form.

D. Form Ties:

E. Form release agent: Non-staining colorless, compatible with finishes, and non-toxic for potable water and NSF 61 certified.
   1. StarSeal EF Bio-Release by Vexcon
   2. Q-2 Form Release by Unitex
   3. Seacord RA II by Concord Chemical

2.2 REINFORCEMENT

A. "Reinforcement" shall include all bars, anchorages, stirrups, dowels, ties, tie-wire, chairs and other steel supports, and spacers, as noted on the Contract Drawings, specified herein, and as required for the proper completion of the Work.

B. Bars: ASTM A615/A615M Grade 60; deformed new materials. Cold bent in accordance with CRSI 10MSP.

C. Welded wire fabric: ASTM A1064/A1064M. Flat sheets are required; rolls are not permitted.

D. Epoxy coated bars: ASTM A775/A775M.

E. Tie wire: ASTM A1064/A1064M, annealed. Provide epoxy coated for epoxy-coated reinforcement and galvanized for architectural concrete.

F. Bolsters, chairs, spacers and other supports to properly position reinforcement shall conform to the "Bar Support" recommendations of CRSI 10MSP and shall be of adequate strength and design to prevent displacement of reinforcement and discoloration of concrete. Where concrete surfaces are exposed to view, weather and/or moisture supports shall be Class 1 Plastic, Plastic Protected, or epoxy coated. Supports for bottom reinforcement for slabs placed on soil or on a mud mat with no more than 3 inches of cover shall be Class 3 chairs with integral plates or precast concrete blocks not less than 4 inches square.

G. Expansion Joint Dowel Bar: Type 316 stainless steel.

2.3 DOWEL BAR SPLICERS

A. Dowel bar splicers shall be used only at joints as shown on the Contract Drawings or only after review with no exceptions taken by the Engineer.

B. Thread bars in shop only.

C. Provide plastic plugs in female end at form.

D. Develop 125% of yield strength of specified bar size across joint.

E. Forged from deformed steel bars conforming to ASTM A615/A615M Grade 60 or ASTM A706/A706M material.

F. Acceptable Products:
   1. Lenton Form Saver by Erico,
   2. Dayton Superior Dowel Bar Splicer System: DB-SAE with DI,
   3. or equivalent.

2.4 MECHANICAL BAR SPLICERS

A. Mechanical bar splicers shall be used as shown on the Contract Drawings or only after review with no exceptions taken by the Engineer.
B. Develop 125% of yield strength of bar across mechanical splice.
C. Acceptable Products:
    1. Lenton Lock B-Series or Lock S-Series Splicing System by Erico,
    2. Dayton Superior Bar-Lock S-Series Coupler System,
    3. Zap Screwlok Type 2 Series, SL Series or Transitions,
    4. or equivalent.

2.5 FABRICATION OF REINFORCEMENT

A. Conform to CRSI Code of Standard Practice-Fabrication.
B. Cold bend bars.
C. Bend bars around revolving collar of recommended size.

2.6 EPOXY ADHESIVE ANCHORS

A. Includes epoxy anchor systems and epoxy adhesive for threaded rods and steel reinforcement.
B. Approved for use in cracked concrete in accordance with ACI 355.4.
C. Materials:
    1. Anchor: AISC Type 316 Stainless Steel threaded rod with washer and nut.
    2. Adhesive:
        a. Epoxy adhesive for anchoring reinforcement to concrete shall be a two-component solid epoxy-based system supplied in manufacturer's standard side-by-side cartridge and dispensed through manufacturer's standard static-mixing nozzle. Except for gel times, epoxy adhesive shall conform to ASTM C881. The Grade, Class and Type of epoxy shall be that which is appropriate for the intended use.

        b. Epoxy adhesive shall pass the creep test requirements of ICC-ES AC308.
        c. Acceptable manufacturers:
            i. SET-XP or ET-HP by Simpson Strong Tie Co., Inc.,
            ii. HIT-RE 500-SD or HIT HY-200 by Hilti, Inc.,
            iii. or equal.
D. Embedment depth for reinforcement: Unless otherwise indicated on the Drawings, the embedment depth shall be per the manufacturer's requirements such that:
    1. The ultimate strength exceeds the tensile strength of the bar.
    2. The ultimate strength divided by a minimum safety factor of 3.75 is at least 40 percent of the yield strength of the bar.

2.7 CONCRETE MATERIALS

A. Each cementitious material shall be furnished from one source throughout the Project.
B. Portland cement: ASTM C150/C150M; Type II.
C. Blended cements: ASTM C595/595M (MS) types, excluding type IS (≥70). Do not use blended cements conforming to ASTM C595/595M if they contain cements conforming to ASTM C1157/C1157M.
D. Supplementary Cementitious Materials:

1. Slag Cement: ASTM C989 - Grade 100 or 120.
2. Silica Fume: ASTM C1240
3. Fly Ash: ASTM C618 - Type F

E. Aggregates:

1. Prohibited: crushed hydraulic cement concrete and recycled aggregate.
2. Fine aggregate
   a. Shall meet FDOT requirements for structural concrete, or
   b. Shall consist of washed inert natural sand, free from mineral or other coatings, soft particles, clay, loam, organic or other deleterious materials conforming to the requirements of ASTM C33/C33M and the following requirements:

SIEVE NO.	PERCENT PASSING
4	95 to 100
8	80 to 100
16	50 to 85
30	25 to 60
50	5 to 30
100	0 to 10
200	0 to 3.0

The Fineness Modulus shall be between 2.3 to 3.1. The percentage retained between any two consecutive sieves shall not exceed 45%.

3. Coarse aggregate shall consist of a well graded crushed stone or a washed gravel conforming to the requirements of ASTM C33/C33M and the following requirements:

	PERCENT PASSING			
SIEVE	NO. 8 (3/8")	NO. 67 (3/4")	NO. 57 (1")	NO. 467 (1 1/2")
1-½ inch	-	-	100	95-100
1 inch	-	100	95-100	-
¾ inch	-	90-100	-	35-70
½ inch	100	-	25-60	-
3/8 inch	85-100	20-55	-	10-30
No. 4	10-30	0-10	0-10	0-5
No. 8	0-10	0-5	0-5	-
No. 16	0-5	-	-	-
No. 50	-	-	-	-

The limits of deleterious substances and physical property requirements shall be as listed in ASTM C33/C33M, Table 4, for severe weathering regions.

4. Fine Aggregate testing: Perform the following tests on samples of the fine aggregate:
    a. Organic Impurities (ASTM C40/C40M):
        i. Color of supernatant liquid above test sample tested in accordance with ASTM C40/C40M shall not be darker than standard (Organic Plate No. 3/Gardner Color Standard No. 11).
        ii. Use of a fine aggregate failing when tested in accordance with ASTM C40/C40M is not prohibited if when tested in accordance with ASTM C87 the relative strength at 7 days is not less than 95%.
    b. Soundness (ASTM C88):
        i. Fine aggregate sample tested in accordance with ASTM C88 for five cycles using magnesium sulfate (not sodium sulfate) shall have a weighted average loss not greater than 18%.
    c. Alkali Reactivity:
        i. Use one of the following three options:
            (1) Test aggregate in accordance with ASTM C1293. Aggregate having an expansion less than 0.04% at 1-year is acceptable for use.
            (2) Test aggregate with the cementitious materials combination submitted in accordance with ASTM C1567. Aggregate having an expansion less than 0.10% at 16 days is acceptable for use.
            (3) Aggregate reactivity shall be categorized in accordance with ASTM C1778 with testing in accordance with ASTM C1293 at 1-year, or ASTM C1260 at 16-days if ASTM C1293 test data is not available. If the coarse and fine aggregates are of different reactivity, the level of protection shall be based on the more reactive aggregate. The alkali content contributed by the portland cement shall not exceed 4.0 lbs per cubic yard of concrete for moderately reactive aggregate and 3.0 lbs per cubic yard of concrete for highly reactive aggregate. The use of very highly reactive aggregate shall not be permitted.
        ii. Evidence of a satisfactory service record in lieu of testing for alkali reactivity is not permitted.
5. Coarse Aggregate testing: Perform the following tests on samples of the coarse aggregate:
    a. Abrasion (ASTM C131/C131M or ASTM C535):
        i. Coarse aggregate shall be tested in accordance with either ASTM C131/C131M (aggregate smaller than 1 1/2”) or ASTM C535 (aggregate larger than ¾”).
        ii. Loss of the mass of the coarse aggregate by abrasion shall not exceed 50%.
    b. Soundness (ASTM C88):
        i. Coarse aggregate sample tested in accordance with ASTM C88 for five cycles using magnesium sulfate (not sodium sulfate) shall have a weighted average loss not greater than 15%.

c. Alkali Reactivity:
   i. Use one of the following three options:
      (1) Test aggregate in accordance with ASTM C1293. Aggregate having an expansion less than 0.04% at 1-year is acceptable for use.
      (2) Test aggregate with the cementitious materials combination submitted in accordance with ASTM C1567. Aggregate having an expansion less than 0.10% at 16 days is acceptable for use.
      (3) Aggregate reactivity shall be categorized in accordance with ASTM C1778 with testing in accordance with ASTM C1293 at 1-year, or ASTM C1260 at 16-days if ASTM C1293 test data is not available. If the coarse and fine aggregates are of different reactivity, the level of protection shall be based on the more reactive aggregate. The alkali content contributed by the portland cement shall not exceed 4.0 lbs per cubic yard of concrete for moderately reactive aggregate and 3.0 lbs per cubic yard of concrete for highly reactive aggregate. The use of very highly reactive aggregate shall not be permitted.
   ii. Evidence of a satisfactory service record in lieu of testing for alkali reactivity is not permitted.

F. Water:
   1. Potable from municipal water supply.

2.8 ADMIXTURES

A. Low Range Water Reducer: MasterPozzolith 210 by Master Builders/BASF; WRDA with HYCOL by GCP Applied Technologies; or equivalent meeting ASTM C494 Type A.
B. High Range Water Reducer (superplasticiser): Rheobuild 1000 or Glenium 3000 NS by Master Builders/BASF; Daracem 100 or ADVA 140M by GCP Applied Technologies; or equivalent meeting ASTM C494 Type F.
C. Water reducing-retarding agents: for use when ambient temperature is above 70°F, replace water reducing agent in whole or in part with water reducing-retarding agent meeting ASTM C494 Type D. Use amounts to produce concrete with a set time equal to that at 70°F without the retarder.
D. Air entraining agent: MasterAir AE 200 by Master Builders/BASF, DAREX II AEA by GCP Applied Technologies; or equivalent meeting ASTM C260.
E. Non-corrosive non-chloride accelerator: MasterSet FP 20 by Master Builders/BASF; Polarset by GCP Applied Technologies; or equivalent meeting ASTM C494 Type C or E.
F. Cementitious Waterproofing: per Section 07100.
G. Not permitted: Calcium chloride, thiocyanates or admixtures containing chloride ions.
H. All admixtures used for each mixture design shall be from one single manufacturer.

2.9 ACCESSORIES

2.10 CONCRETE CLASS

2.11 CONCRETE MIXTURE DESIGN

A. Concrete
   1. All Concrete shall have a minimum compressive strength equal to f'c = 4,500 psi, max w/cm = 0.42, min w/cm = 0.39

B. Maximum nominal aggregate size:
   1. Coarse aggregate shall conform to the grading given in Table 3 of ASTM C33/C33M for sizes (i.e., nominal maximum aggregate sizes) No. 467 (1 ½"), No. 57 (1"), No. 67 (3/4"), No. 7 (1/2"), and No. 8 (3/8").
   2. Nominal maximum aggregate size shall be as follows:
      a. 1 ½": All slabs placed on ground, foundation mats and footings, and walls that are at least 15 inches thick, except where the clear spacing between reinforcement bars is less than 2 inches.
      b. ¾": All other locations, except as specified elsewhere or upon written approval of the Engineer.
      c. Concrete Fill:
         i. ½": minimum thickness less than 2 ¼ inches and fills screeded into place by process equipment,
         ii. ¾": minimum thickness from 2 ¼ inches to less than 6 inches,
         iii. 1 ½": minimum thickness of 6 inches or greater
      d. Electrical Ductbanks: 3/8"
      e. Mud slab: 3/8", ½" or ¾"

C. Air entrainment:
   1. All concrete, except as noted below, shall be air entrained in accordance with the nominal maximum aggregate size, with a tolerance of plus or minus 1.5%:
      a. No. 8 (3/8") – 7.5%
      b. No. 7 (½") – 7.0%
      c. No. 67 (¾") – 6.0%
      d. No. 57 (1") – 6.0%
      e. No. 467 (1 ½") – 5.5%
   2.

D. Supplementary cementitious materials may be included as follows.
   1. Portland Cement - No less than 50% of the total by weight.
   2. Slag Cement - If used, no less than 25% and no greater than 35% of the total by weight.
   3. Silica Fume –If used, no less than 5% and no greater than 10% of the total by weight.
   4. Fly Ash - If used, no less than 15% and no greater than 25% of the total by weight.
   5. Total Fly Ash + Slag + Silica Fume – No greater than 50% of the total by weight.
   6. Total Fly Ash + Silica Fume – No greater than 35% of the total by weight.

E. The slump shall be 4” with a 1” plus or minus tolerance at the point of delivery, without use of a high range water reducer. When a high range water reducer is used, the slump shall be as stated above before it is added, and a maximum of 8” at the point of delivery after it is added.

F. Water:
   1. The amount of water carried on the aggregate and the effect of admixtures is included in the water content. Provide that water carried on the aggregate is determined periodically by test and the amount of free water on the aggregate is subtracted from water added to the mixture.
   2. Maximum amount of water: that required to produce a plastic mixture of the strength and water to cementitious materials ratio specified and the required density, uniformity and workability. Consistency of the mixture: that required for the specific placing conditions and methods.

G. High Range Water Reducing admixtures shall be used for all concrete to be pumped or with a specified water to cementitious ratio below 0.50. High range water reducer shall be added either at the concrete batch plant or on site to obtain the slumps as indicated above.

H. Concrete shall be furnished from one supplier and batch plant during the project.

2.12 SELECTION OF CONCRETE PROPORTIONS

A. The Concrete producer shall select the concrete mixture proportions on the basis of past field performance or the use of trial mixtures, both in accordance with ACI 301, Section 4, "Concrete Mixtures".

B. Adjustments to required average strength (f’cr):
   1. Adjustments in the required average strength may be made during the progress of the work to compensate for either high or low average compressive strengths.
   2. When a minimum of fifteen 28-day compressive strength tests from this project are available, the average strength and standard deviation shall be computed.
   3. Should these determinations indicate an excessive compressive strength with a low standard deviation as determined by the Engineer, modification of the concrete mixture may be made to achieve a lower average strength based upon a new standard deviation.
   4. Should these determinations indicate a lower average strength than anticipated, the Engineer will require corrective measures to be taken immediately which may include one or more of the following but not limited to:
      a. An increase in the cementitious materials
      b. Changes in mixture proportions
      c. A reduction in the delivery time
      d. Closer control of air content.
      e. Decrease in the water to cementitious materials ratio.
      f. An improvement in the quality of the testing, including strict compliance with standard test procedures.
      g. Procedural changes as deemed necessary by the Engineer.

2.13 STORAGE OF MATERIALS

A. Protect materials from ground and the elements.

B. Maintain cement in dry condition.

C. Store reinforcement and all other embedded items on skids.
D. Store PVC waterstops in a location that is protected from sunlight, precipitation, soiling, etc. Keep surface applied waterstops dry.
E. Remove defective materials, as determined by the Engineer, from site immediately. Do not store on site.

PART 3 - EXECUTION

3.1 FORMWORK

A. Conform to ACI 301.
B. Verify lines, level, and measurements before proceeding.
C. Erect plumb and straight. Maintain rigid. Brace sufficiently.
D. Allow no concrete leakage. Provide continuous, straight, smooth exposed surfaces.
E. Treat forms with form release agent prior to erecting forms. Do not apply form release agent at formed surfaces of construction joints designed with continuous reinforcement and remove all traces from formed joint prior to subsequent concrete placement. Protect reinforcement from contact with form release agent. Form release agent that contacts reinforcement shall be thoroughly removed.
F. Earth forms not permitted for below grade walls, slabs and footings.
G. Camber formwork as necessary.
H. Provide removable wall panels to allow cleaning and inspection.
I. Chamfer all exposed outside corners and edges 0.75 inch unless otherwise noted.
J. Clean out inside of forms of all foreign materials prior to concrete placement.
K. Install architectural form liner and rustication strips according to Manufacturer's recommendations.
L. Install reinforcement spacers in slabs, beams, walls, columns, and all other concrete members as required to maintain specified clear cover.
M. Maintain specified tolerances.
N. Maintain forms and shores supporting the cast concrete for the minimum time periods indicated below:
    1. Walls and Vertical Surfaces:
        a. Walls containing liquids (subjected to internal hydrostatic pressure) and backfilled walls of interior spaces - 48 Hours
        b. All other walls – 36 hours
        c. Forms may be unlocked after 24 hours but shall remain in place for the indicated time periods
    2. Elevated Beams and Slabs :
        a. “Clear span” of slabs shall be the shorter span of a slab panel.
        b. Clear spans less than 10 feet – 4 days
        c. Clear spans between 10 feet and 20 feet – 7 days
        d. Clear spans greater than 20 feet – 14 days
    3. Time periods listed above represent cumulative number of days or hours during which the temperature of the air surrounding the concrete is above 50°F and the concrete has been damp and no loss of moisture has occurred.

4. Alternate form removal periods:
    a. Alternately to the stripping times specified above, additional concrete cylinders may be made of representative concrete, field-cured, and tested at no additional cost to the Owner.
    b. The supporting forms and shores may be removed when the concrete strength of the field-cured cylinders, as tested per ASTM C39/C39M is a minimum of 70 percent of the specified design strength.
    c. General Contractor shall notify the Engineer 24 hours in advance of casting the field-cured cylinders.
    d. Field-cured cylinders - where noted on the plans and/or when used by the Contractor, specimens shall be field-cured in accordance with ASTM C31/C31M under conditions that are not more favorable than the most unfavorable conditions for the portions of the concrete that the test specimens represent.

O. Reshore as required.

P. Form pressures increase with the use of concrete with High Range Water Reducers. Design forms accordingly.

Q. Clean and repair surfaces of forms to be re-used in work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable for exposed surfaces. Apply new form release agent as specified for new formwork.

3.2 REINFORCEMENT

A. Conform to the CRSI Code of Standard Practice.

B. Do not weld reinforcement unless the Engineer takes no exceptions - in writing. When permitted, welding shall be in accordance with AWS D1.4/D1.4M.

C. Splicing reinforcement:
    1. Welded wire fabric: Install in longest sheets practical. Welded wire fabric shall be lapped 1½ wire spacings and a minimum of 12 inches and securely tied at maximum 24 inches on center. Offset end laps in adjacent sheets.
    2. Reinforcement bars: Splices shall be located as shown on the Contract Drawings. Where not shown, splices shall be located away from areas of maximum stress, and shall be reviewed, with no exceptions taken, by the Engineer. Minimum splice lengths shall be as indicated on the Contract Drawings.

D. Provide bar supports and spacers.

E. Reinforcement shall be securely tied at intersections with tie wire or clips in a manner that will keep all metal away from exposed concrete surfaces.

F. Cutting, heating, and bending of reinforcement embedded in the concrete will not be allowed.

G. Mechanical connections shall be installed in accordance with the manufacturer's recommendations and as shown on the Drawings. Additional mechanical connections proposed by the Contractor will not be allowed unless the Engineer has reviewed and takes no exceptions in writing.

H. Epoxy coating damaged shall be repaired with patching material conforming to ASTM A775/A775M.

I. All parts of mechanical connections on epoxy coated reinforcement, including steel splice sleeves, bolts and nuts shall be coated with the same material used for repair of epoxy coating damage.

J. All reinforcement within an area of a continuous concrete placement shall be installed, supported, and secured before beginning concrete placement.

3.3 EMBEDDED ITEMS

A. Contractor shall coordinate the installation and securing of all embedded items such as anchor rods, dovetail slots, waterstops, pipes, conduit, pipe hanger inserts, nosings, embedded angles, steel dowels and all other required embedded items indicated in the Contract Documents.

B. Expansion joint dowels shall be held horizontally in forms to prevent displacement and to allow at least one inch of expansion after installation.

C. Contractor shall coordinate number and layout of masonry dowels with the mason prior to installation.

D. All embedded items shall be secured prior to concrete placement. Embedded items shall not be placed during or after concrete placement.

E. Pipes or conduits for embedment within a slab, wall or beam, other than those merely passing through, shall satisfy the following:

1. Shall not be larger in outside diameter than one-third (1/3) the thickness of the slab, wall, or beam.
2. Shall not be spaced closer than 3 diameters on center.
3. Shall not significantly impair the strength of the concrete.
4. Shall not be embedded in structural concrete slabs less than 6 inches
5. Only two conduits or pipes shall cross at any point. The sum of the outside diameter of the crossing pipes or conduits shall not exceed one-third (1/3) of the thickness of the concrete thickness.
6. Conduit shall not be located between the bottom of reinforcement and bottom of concrete slab or beam.
7. Aluminum conduit shall not be embedded in concrete.
8. Conduit shall be installed such that there will be NO cutting, bending, and/or displacement of reinforcement from its proper location.
9. Conduit and/or pipes shall not pass through a waterstop in slabs, beams, or walls.
10. Conduit shall not be installed prior to review of conduit layout plan with no exceptions taken by the Engineer.
11. Voids cast into concrete slabs and walls for pipes or conduit and subsequently filled with concrete or grout shall not be installed unless reviewed with no exceptions taken by the Engineer.

3.4 EPOXY ADHESIVE ANCHORS

A. Anchors shall be installed by qualified personnel trained to install expansion and adhesive anchors.

B. Anchors shall be installed in strict accordance with the Manufacturer’s Printed Installation Instructions (MPII).

C. Each installer shall at all times have in their possession the MPII.

D. Adhesive anchors shall be installed in concrete having a minimum age of 21 days at time of installation.
E. All adhesive anchor cartridges shall have the expiration date clearly visible. Material past its expiration date shall not be used and shall be immediately removed from the site.
F. Embedded reinforcement shall be located with proper equipment prior to drilling to ensure that each drilling location does not coincide with existing reinforcement. Drilling through reinforcement shall be prohibited.
G. If existing reinforcement is encountered while drilling, offset the drill hole by a maximum of 2-inches. The new relocated hole shall be in the same line as the line of drilled holes. All offset holes shall be a minimum of 4-inches from a free concrete edge. Maintain the original spacing locations of the remaining dowels as indicated on the Contract Drawings.
H. Diamond drill bits shall not be permitted. Hammer drills shall be used.
I. The initial material extruded from each adhesive anchor cartridge shall be discarded in accordance with the manufacturer's instructions to ensure that all material is properly mixed.
J. Depth stop shall be used to ensure correct drilling depth. Drilled holes shall be blown out with air, thoroughly wire-brushed with a repeated back and forth movement, blown out, thoroughly wire-brushed, and blown out again. Adhesive shall be injected starting from the bottom of the hole, and slowly withdrawn as filling progresses to prevent air pockets.
K. Anchored reinforcement shall remain completely undisturbed between manufacturer's specified gel time and the full cure time. Zero load shall be applied during this time.

3.5 PLACING CONCRETE

A. Notify Engineer and Independent Testing Laboratory 24 hours minimum prior to each placement.
B. All reinforcement within the area of one day's concrete placement shall be tied in place, and observed by the Engineer, prior to commencing concrete placement.
C. All concrete delivery trucks at each placement shall be tested as specified in Section 03305.
D. Assure placement and proper location of all embedded items.
E. Provide concrete Delivery Slip prepared at batch plant with each truck load of concrete showing the information listed under Submittals in this Section.
F. Water: water added after batching shall be carefully monitored as follows:
    1. Residual, wash, and/or other water in drums: completely discharge prior to concrete batching (drums backed out).
    2. Slump adjustment: not permitted at wash down, "slump rack", or by any other means between the time of batching to the point of delivery at the Project site.
    3. Water added after arrival at Project site: accurately metered and recorded on the delivery ticket. The Engineer's Resident Project Representative shall be notified prior to the addition of water.

4. No additional water shall be added to the concrete on site that will increase the water to cementitious materials ratio above that specified. If additional water is to be added on site, it shall be held back during batching from the quantity specified in the mixture design. The amount of water held back shall be clearly indicated on the concrete delivery slip, and the addition of more water than indicated shall be cause for non-compliance and rejection of the concrete truck.

G. Place concrete from mixing truck to final location quickly and without segregation.

H. Place all concrete from the delivery truck within 90 minutes of addition of water to cement, or cement to aggregate, whichever occurs first. When air temperature is 90°F and above, this time shall be reduced to 60 minutes. These times may be exceeded only upon review with no exceptions taken by the Engineer, and only if all tests for air content, slump and temperature are also within specified limits.

I. Standing water shall be removed from all forms and excavations and the Work shall be kept dry during concrete placement. No water shall be thrown on, allowed to flow over, or rise upon the concrete until the concrete surface has reached its final set and is rigid.

J. Runways shall be provided for wheeled concrete handling equipment. Runways shall not be supported upon placed reinforcement.

K. Concrete truck chute shall conform to the following:
   1. Minimum slope: 3 horizontal to 1 vertical. Maximum slope: 2 horizontal to 1 vertical. Between these limits the chute slope shall be such to ensure continuous flow without segregation.
   2. Provide baffle at end of chute to prevent segregation. If the end of the chute is more than 3 feet above the surface of deposit, a spout is to be used. The spout is to be kept full of concrete with the end kept as near as practical to the surface of the deposit.
   3. The chute shall be steel or steel lined. Aluminum chutes are not permitted. Sections of the chute shall have the same slope throughout.
   4. The chute is to be thoroughly flushed with water before and after each use with the water discharged outside the forms.

L. Freefall from concrete truck discharge chute, pump hose and hopper hose: 4 feet maximum.

M. The accumulation of concrete on the forms and/or reinforcement above the level of placement shall be avoided. The splashing of concrete upon formwork that is set for a subsequent concrete placement shall be prevented due to the resulting marks on the finished concrete.

N. Concrete placements shall be carried out in a continuous operation until the placement of the entire section between construction joints is complete. Place against plastic concrete only.

O. Do not place partially hardened concrete. Re-tempering is not permitted.

P. Compacting and vibrating concrete:
1. Consolidate each layer by mechanical internal vibrating equipment supplemented by hand spading, rodding, and tamping as required. The depth of each layer shall not exceed the smaller of 20 inches and the depth that can be properly vibrated with the equipment used. When deposited in multiple layers, the vibrator shall penetrate the preceding layer approximately 6 inches to blend layers. Ensure that initial setting of the previous layer doesn't occur prior to placement of subsequent layer.
2. Do not use vibrator to move fresh concrete within the forms. Insert vibrator at approximately 18-inch intervals, and over-vibration resulting in segregation shall be prevented.
3. Concrete shall be thoroughly consolidated around reinforcement, embedded items and into corners of forms.
4. Ensure that vibrator is kept several inches clear of waterstops.
5. Where internal vibration is impractical, the use of form vibrators will be considered, and will be allowed only with the review with no exceptions taken by the Engineer. When allowed, the vibrator shall be placed so that motion is horizontal.
6. Vibratory screeds are acceptable for slabs up to 8 inches thick, however internal vibration is required in areas of load-transfer dowels and electrical conduit. Internal vibration is required for slabs thicker than 8 inches.

Q. Placing concrete in cold weather:
1. Conform to ACI 306.1 for concrete placements in cold weather as defined in Section 03346. When freezing temperatures may occur during periods not defined as cold weather, concrete surfaces shall be protected against temperatures lower than 35 degrees, as measured by the Engineer, for at least the first 24 hours after placement.
2. Concrete shall conform to the following temperature limitations “as placed and maintained” and “as mixed”, respectively. The minimum temperature maintained shall be for a minimum of 6 days, or 4 days with use of an accelerator, and shall be as measured at the concrete surface by the Engineer:

		Concrete Thickness			
Item	Air Temperature	Less than 12 in	12-36 in	36-72 in	Greater than 72 in
Minimum concrete temperature as placed and maintained					
1	--	55°F	50°F	45°F	40°F
Minimum concrete temperature as mixed for indicated air temperature					
2	Above 30°F	60°F	55°F	50°F	45°F
3	0 to 30°F	65°F	60°F	55°F	50°F
4	Below 0°F	70°F	65°F	60°F	55°F

3. The concrete placement temperature shall not be higher than the minimum concrete placement temperature (in the table above) by more than 20°F.
4. An accelerator may be used in the mixture design when placing concrete in air temperatures below 50°F.

5. All material and equipment required for cold weather placement, protection and curing shall be available at the project site before commencing concrete placement.
6. Any enclosure for weather and climate protection shall be in place before depositing any concrete. Heating within the enclosure shall maintain the temperature specified with a reasonable degree of uniformity in all parts of the enclosure. All exposed concrete surfaces within the enclosure shall be kept sufficiently moist to prevent drying. Heating appliances shall not be placed in a manner so as to damage the enclosure, forms, supports, or expose any area of concrete to drying out or to excessive temperatures.
7. The use of direct fired heaters including salamanders and torpedoes is not permitted due to the potential damage to concrete surfaces exposed to elevated levels of carbon dioxide, which can result in soft, chalky surfaces and dusting throughout the life of the structure. Heaters shall be indirect fired heaters with combustion exhaust vented outside the enclosure.
8. All snow, ice and frost shall be removed from the surfaces against which the concrete is to be placed including subgrade and reinforcement.
9. Do not place concrete on frozen ground. Insulate or heat subgrade to ensure temperature of subgrade material is above 32°F when concrete is placed.
10. All embedded items having a cross sectional area of 1.00 square inches or greater, including #9 and larger steel reinforcement, shall be at a temperature not less than 10°F at time of concrete placement.
11. Cover, insulate and/or heat as required to protect concrete and provide frost protection beneath structure. Thermal protection shall be provided immediately after concrete placement. Except when supplemental heat is provided, the R-value of the insulation shall be per the recommendations of Chapter 9 of ACI 306R.

R. Long-term cold weather protection of non-air-entrained hard troweled concrete slabs:
1. After the curing period (at which time they are protected), the surface temperature shall be maintained at a minimum of 35°F for a minimum of 8 weeks.
2. Thereafter, and for the duration of the Contract, if such slabs might be subjected to freezing temperatures they shall be fully sheltered from rain, snow, and all other water sources.
3. The surface temperature shall be as measured by the Engineer.

S. Placing concrete in hot weather:
1. Hot Weather: Job-site conditions that accelerate the rate of moisture loss or rate of cement hydration of freshly mixed concrete, including an ambient temperature of 80°F or higher, and an evaporation rate that exceeds 1 kg/m2/h.
2. Temperature of concrete when placed shall not exceed 90°F. When the air temperature is 90°F and above, procedures to cool mixture ingredients shall be employed. These include:
    a. Providing shaded storage for aggregate,
    b. Frequent sprinkling or fog spraying of coarse aggregate,
    c. Using chilled batch water and/or ice.

3. Forms and reinforcement shall be sprinkled with cold water just prior to concrete placement. When possible, placement of slabs should be scheduled accordingly in order to minimize problems associated with direct sunlight and/or drying winds.

T. Pumping: The inside diameter of pipes and hoses used to convey the concrete shall be a minimum of three times the maximum size aggregate of the mixture. In order to minimize altering the concrete properties, long vertical sections at the end of the pump line is prohibited. A horizontal hose run, a hose loop, or a slide gate at the end of the hose is to be used to reduce loss of entrained air.

U. Thoroughly moisten subgrade materials prior to placing slabs on grade.

V. When placing new concrete directly against existing concrete, clean the surface of all contamination and debris, and roughen by steel shot-blasting, abrasive (sand) blasting, or water-jetting (hydrodemolition). Use of scabblers, scarifiers, bush hammers, or pneumatic hammers is not permitted. The prepared surface shall be water-saturated for a minimum of six hours, and the excess water shall be removed immediately prior to placement of concrete. Apply specified bonding agent to the prepared surface to bond to new concrete.

W. Provide concrete pads and foundations for all equipment as shown on Drawings or as required by the equipment manufacturer. Set anchor bolts for equipment with templates at correct elevations using manufacturer's shop drawings reviewed by the Engineer with no exceptions taken unless otherwise indicated. All equipment pads shall be sized by the Contractor and equipment supplier except as otherwise indicated on the Drawings.

X. Contractor shall coordinate concrete truck wash-out area with Owner.

3.6 JOINTS

A. Saw cut joints:

1. Early-entry dry-cut saws shall be used unless otherwise permitted in writing by the Engineer. Sawing shall be performed as soon as the concrete has hardened sufficiently to prevent dislodgment of aggregates and edge raveling – normally between 1 and 4 hours after finishing. When use of wet cut saws is permitted, sawing shall be completed within 8 hours of concrete placement. Preformed embedded control joint strips may be used in lieu of saw cutting.
2. The depth of saw cut joints shall be as indicated on the Contract Drawings.
3. If a crack forms in the slab, propagating from the end of the partially completed sawed joint, the Contractor shall stop sawing the joint. The Contractor shall route out the crack in a concave configuration and fill the routed crack with the specified joint filler. Routing need not occur immediately.
4. Concrete sawing machines shall be adequate in number and power, and with sufficient replacement blades to complete the sawing at the required rate. Joints shall be cut to true alignment and shall be cut in sequence of concrete placement. Sludge and cutting debris shall be removed.
5. Temporary plastic joint inserts shall be provided in order to prevent spalling where joints intersect.
6. Prior to completion of joint filler installation, sawed joints shall be protected against edge spalling due to any and all traffic and/or work occurring on the slab.

7. Provide sawed joints only where shown on the drawings or as otherwise approved after written request.

B. Install PVC waterstops in joints in all liquid containing structures and below grade walls adjacent to interior spaces, unless otherwise shown on the Drawings. The waterstop shall extend the entire length of the joint and shall be positioned across the center of the joint.

C. Install PVC waterstops in all joints at containment curbs unless otherwise shown on the Drawings.

D. Apply bondbreaker to surface of control joints.

E. Install keys as indicated. Provide a minimum 2" clearance between edge of key and reinforcement.

F. Prepare joints as follows:
   1. Horizontal joints: remove laitance immediately after initial set and roughen surface in an acceptable manner that exposed the aggregate uniformly and doesn't leave laitance or loose aggregate. After the concrete has set to a stiffness that precludes laitance removal by shovels or scrapers, the Contractor shall remove it and create a roughened surface by water-jetting or other effective method. The use of pneumatic hammers is not permitted.
   2. Vertical joints: the surface shall be thoroughly cleaned of laitance by water-jetting or wire-brushing followed by air blasting.
   3. Before concrete is placed against set concrete, the surface shall be thoroughly wetted with standing water removed. Horizontal construction joints shall be in a saturated surface dry condition: saturated for a minimum of 6 hours, with standing water removed.

3.7 TOLERANCES

A. Tolerances shall conform to all requirements of ACI 117.

3.8 FAILURE TO MEET STRENGTH REQUIREMENTS

A. The strength of the concrete in place will be considered substandard if any one of the following results occur (where a strength test is defined as the average of two 6"Ø x 12" cylinders or three 4"Ø x 8" cylinders):
   1. The average any three (3) consecutive strength tests at 28 days is less than the specified strength (f'c).
   2. A compressive strength test result falls below the specified strength (f'c) by more than 500 psi.

B. Concrete which fails to meet the strength requirements as outlined above will be reviewed by the Engineer. The Engineer will determine whether the substandard concrete will be accepted, rejected or additional tests performed.

C. When substandard concrete occurs as defined in Part A, the Engineer will require corrective measures to be taken immediately to increase the average of subsequent strength tests. In addition, the Engineer may require cores drilled in the area of question in accordance with Specification 03305. If the core tests are inconclusive or impractical to obtain, load tests may be required, and their results evaluated in accordance with ACI 318. If the average of the three cores is less than 85% of the specified strength or if one core is less than 75% of the specified 28-day strength, then that portion of the structure shall be strengthened by a method proposed by the

Contractor and no exceptions taken by the Engineer or replaced by the Contractor at no additional cost to the Owner.

3.9 DEFICIENT CONCRETE

A. Concrete work will be considered deficient if it does not conform to strength and material durability requirements (including water to cementitious materials ratio), location, elevation, dimension, shape, alignments, and/or appearance as required in the Contract Documents. Specific examples of deficient concrete include (but are not limited to):
   1. Concrete containing reinforcement that does not meet the requirements of the Contract Documents for size, quantity, strength, position, or arrangement.
   2. Concrete which differs from the required dimensions or locations in such a manner as to reduce the strength.
   3. Concrete surfaces not finished or cured in accordance with Section 03346.
   4. Concrete work in hot or cold weather that doesn't meet the requirements of the Contract Documents.
   5. Formed surfaces larger or smaller than specified dimensional tolerances. If the Engineer permits the Contractor to correct the error, such correction shall be as directed and in such a manner as to maintain the strength, function and appearance of the structure.
   6. Concrete members cast in the wrong location may be rejected and shall be removed at no additional cost to the Owner if the strength, appearance or function of the structure is adversely affected.
   7. Concrete exposed to view with defects that adversely affect the appearance of the specified finish shall be repaired. If, in the opinion of the Engineer, the defects cannot be repaired, the concrete may be rejected by the Engineer. Examples include:
      a. Non-uniform appearance including texture and color
      b. Excessive visible repairs of structural defects
   8. Concrete work damaged from accidents, poor construction practices or fire.

B. Any deficient concrete may be subject to rejection and replacement at no additional cost to the Owner if the Engineer deems necessary.

END OF SECTION

SECTION 03305

CONCRETE TESTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Concrete Testing

1.2 RELATED SECTIONS

A. Section 01340 - Submittals
B. Section 01400 - Quality Control
C. Section 03300 - Cast-In-Place Concrete
D. Section 03346 - Concrete Finishing, Curing and Repairs

1.3 REFERENCES

A. ASTM C31/C31M-10 - Standard Practice for Making and Curing Concrete Test Specimens in the Field
B. ASTM C39/C39M-10 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
C. ASTM C172-10 - Practice for Sampling Freshly Mixed Concrete
D. ASTM C231-10 - Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
E. ASTM E329-11 - Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction
F. ASTM C1602/C1602M-06 - Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
G. ACI 301-10 - Standard Specifications for Structural Concrete
H. ACI 350.1-01/350.1R-06 - Tightness Testing of Environmental Engineering Concrete Structures

1.4 QUALIFICATIONS

A. Independent Testing Laboratory shall conform to concrete testing requirements of ASTM E329.
B. Key personnel must be qualified and experienced in concrete quality assurance.
C. Perform concrete field quality control testing with personnel certified as an ACI Concrete Field-Testing Technician, Grade 1 according to the American Concrete Institute (ACI).

1.5 SUBMITTALS

A. The Contractor shall be responsible for the submittals for review and acceptance by the Engineer at no additional cost to the Owner. Submittals shall include Independent Testing Laboratory’s qualifications, all testing reports, etc.

B. Independent Testing Laboratory will submit one copy each of all test reports to each of the following: Engineer, Resident Project Representative, Contractor and concrete supplier. Reports shall indicate the following information:

Project	Air content
Placement Location	Cure box min/max temps
Contractor	Cylinder Nos
Concrete supplier	Cylinder weights
Technician	Date of breaks
Date cast	Break type
Date picked up	Break load
Design strength	Break strength
Air temp	Truck Arrival Time
Concrete temp	Truck Unload Time
Initial slump	Lab/Field cured
Final slump	Cylinder size

C. Independent Testing Laboratory will submit reports within 5 days of testing or inspection.

D. Independent Testing Laboratory will telephone the Engineer within 24 hours if tests indicate deficiencies.

PART 2 - EXECUTION

2.1 CAST-IN-PLACE CONCRETE

A. An Independent Testing Laboratory, selected and paid for by the Owner and directed by the Engineer and/or Resident Project Representative, shall test and sample Class A concrete for strength, slump and air content as indicated herein.

B. The General Contractor shall notify the Independent Testing Laboratory of proposed upcoming concrete placements as follows.
   1. The General Contractor shall notify the Testing Laboratory of proposed concrete placements on a weekly basis.
   2. The General Contractor shall notify the Testing Laboratory of specific placements a minimum of 24 hours in advance.

C. Obtain 5 standard test cylinder samples measuring 8 test cylinders measuring 4"Ø x 8" for each class of concrete placed in any one day at the following frequency:
   1. For each 100 cubic yards of placed concrete, or
   2. For each placement less than 100 cubic yards

D. Concrete cylinders shall be tested as follows:
   1. 4” Ø x 8” cylinders:
      a. Test 3 cylinders at 7 days; 3 cylinders at 28 days.
      b. Hold two cylinders for later testing (if required)

E. Perform slump tests and air entrainment tests at the project site on each truck and at each sampling. Perform slump and air entrainment tests before addition of High Range Water Reducer (when the high range water reducer is added on site) and slump and air entrainment tests after addition of High Range Water Reducer (all concrete).

F. Sample concrete for testing of air and slump at the discharge end of the truck. When concrete is pumped, concrete taken for test cylinders shall be at the discharge end of the pump hose. All concrete sampled for testing shall be taken from the beginning of the concrete truck discharge. No concrete shall be placed until the testing is complete. All concrete sampled for casting of cylinders shall be taken from the middle third of the concrete truck discharge.

G. Perform strength, slump and air entrainment tests at other times when directed by the Resident Project Representative.

H. Additional testing and sampling required as a result of deficient results or improper curing shall be paid for by Owner. The cost of resampling and retesting will be determined by Engineer, and Owner will invoice Contractor for this cost. If unpaid after 60 days, this invoice amount will be deducted from the Contract Price.

I. Contractor shall provide and maintain an insulated, heated concrete cylinder curing box, 4 foot square minimum, with a min.-max. thermometer and maintain the temperature between 60*F and 80*F. Contractor to coordinate the location and specific details of the curing box with the Resident Project Representative and Independent Testing Laboratory.

J. Contractor shall provide access to the site at all times for the Independent Testing Laboratory Personnel.

2.2 ADDITIONAL TESTS

A. Independent Testing Laboratory shall provide additional testing of in-place concrete that does not comply with the requirements of the Contract Documents or is considered substandard as directed by Engineer. Additional tests may consist of non-destructive testing, cores drilled from the area in question or load tests. Costs of additional testing will be paid by Owner. The cost of the additional testing will be determined by Engineer and Owner will invoice Contractor for that cost. If unpaid after 60 days, the invoice amount will be deducted from the Contract Price.

B. When the concrete strength is substandard as defined in Specification 03300 Section 3.12 paragraph A, concrete core specimens shall be obtained and tested from the affected area. A minimum of Three (3) cores shall be taken for each sample in which the strength requirements were not met. The drilled cores shall be obtained and tested in conformance with ASTM C 42 “Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete”. Engineer will determine the size and location of the required core samples.

C. Field cured cylinders may be cast and tested by the Independent Testing Laboratory at the request of the Contractor. The costs of these tests shall be borne by the Contractor. If the field cured cylinders are cast and tested prior to 28-days to determine the in-place concrete strength in order to facilitate an accelerated schedule for subsequent concrete placements, or backfilling or leakage testing, the following criteria must be met:

1. The Contractor shall notify the Engineer and Independent Testing Laboratory 48 hours in advance of the concrete placement. The Engineer will determine at that point if the results of the field cured cylinders may be used to determine the in-place concrete strength. The Contractor shall notify the Engineer as to when the field cured cylinders will be tested and for what purpose.

2. A minimum of three 4"Ø x 8" cylinders shall be cast for each separate test the Contractor requests.
3. The field cured cylinders shall be left in the field and located such that they are exposed to the identical environmental conditions as the concrete structure. The cylinders shall remain at this location a minimum of 14 days prior to testing.
4. The Engineer shall determine if the strengths indicated by the field cured cylinder tests are adequate for their intended purpose.

2.3 PRECAST STRUCTURAL CONCRETE

A. Independent Testing Laboratory shall inspect precast plant(s) during first major casting of product for project at the request of the Engineer.
B. Notify Independent Testing Laboratory 72 hours in advance of first major casting.
C. Independent Testing Laboratory shall inspect batching and mixing equipment, storage of materials, placement of reinforcement of forms, mix design, concrete testing, concrete placement, curing, general quality control procedures.
D. Independent Testing Laboratory shall provide report to Engineer and Contractor within 5 days.

END OF SECTION

SECTION 03346

CONCRETE FINISHING, CURING, MODIFICATIONS AND REPAIRS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Concrete Finishing, Curing, Modifications and Repairs

1.2 RELATED SECTION

A. Section 01340 - Submittals
B. Section 03300 - Cast-in-Place Concrete
C. Section 03604 - Non-Shrink Grout
D.

1.3 REFERENCES

A. This section contains references that are applicable to this Specification Section. The applicable edition of the indicated references shall be the version that was the most current at the time of the Advertisement of Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued, or replaced.
B. ACI 301 – Standard Specifications for Structural Concrete
C. ACI 306.1 – Standard Specification for Cold Weather Concreting
D. ACI 306R – Cold Weather Concreting
E. ACI 308.1 – Standard Specification for Curing Concrete
F. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete
G. ASTM C309 – Standard Specification for Liquid Membrane - Forming Compounds for Curing Concrete
H. ASTM C1059 / C1059M - Standard Specification for Latex Agents for Bonding Fresh To Hardened Concrete
I. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete
J. ASTM C1602/C1602M – Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Production
K. ASTM E1155 - Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers

1.4 SUBMITTALS

A. Submit product data and material safety data sheets for curing compounds, floor sealers and floor hardeners. Indicate the intended use and location for all products.

B. Submit product data and material safety data sheets for repair materials. Indicate the intended use and location for all products.
C. Submit methods to be used to protect the concrete during cold weather curing periods. The Engineer's review shall be for information only as the Contractor is responsible for the means and methods of protection of concrete placed during cold weather.
D. Submit methods to be used to protect the concrete during hot weather curing periods. The Engineer's review shall be for information only as the Contractor is responsible for the means and methods of protection of concrete placed during hot weather.
E. Submit curing methods. Submittal shall be presented in a table format indicating each structure and how all of the individual components of each structure will be cured.
F. Submit qualifications of flatwork finishers.
G. Contractor shall submit all requested information prior to the pre-Concrete meeting described in Section 03300.

1.5 ENVIRONMENTAL CONDITIONS

A. Environmental Conditions are defined as follows:
1. Cold Weather:
a. Cold weather is defined as any and all periods when for more than three consecutive days the average daily outdoor temperature drops below 40°F. (The average daily temperature is the average of the highest and lowest temperature during the period from midnight to midnight.) When temperatures higher than 50°F occur during more than half of any 24-hour duration, the period shall not be regarded as cold weather.
b. When freezing temperatures may occur during periods not defined as cold weather, concrete surfaces shall be protected against freezing for at least the first 24 hours after the concrete placement.
2. Hot Weather - Job-site conditions that accelerate the rate of moisture loss or rate of cement hydration of freshly mixed concrete, including an ambient temperature of 80°F or higher, and an evaporation rate that exceeds 1 kg/m2/h.

1.6 QUALITY ASSURANCE

A. Perform work in accordance with ACI 301, ACI 306.1 and ACI 308.1, except as modified herein.
B. All curing, finishing and repair materials shall meet all Federal and State regulations pertaining to Volatile Organic Compounds (VOC) Compliance.
C. Contractor performing flatwork finishing of concrete slabs shall provide at least one (1) flatwork finisher certified as an ACI Concrete Flatwork finisher.
D. All products.

PART 2 - PRODUCTS

2.1 CURING MATERIALS

A. Curing and Sealing Compound:
1. Conform to ASTM C309 Type 1 Class B.

2. Acceptable products:
    a. Emulsion Kurseal 309 by A.H. Harris & Sons, Inc.
    b. Aqua-Cure VOX by Euclid
    c. Starseal EF Cure 500 by Vexcon
    d. Or equivalent.

B. Curing/Hardening Compound:
1. Sodium Silicate Type
2. Acceptable products:
    a. Eucosil by Euclid Chemical Company,
    b. Super KurHard by A.H. Harris & Sons, Inc.
    c. Or equivalent.

C. Curing, Sealing and Hardening Compound:
1. Acrylic water-based compound
2. Acceptable products:
    a. Ashford Formula by Curecrete,
    b. Starseal EF Medium Gloss by Vexcon
    c. Super Kurseal 800 Emulsion by A.H. Harris,
    d. Or equivalent.

D. Curing Water: Water shall be potable from a municipal water supply or shall meet the requirements of ASTM C1602, and shall be free of materials that have the potential to stain concrete. The temperature of the curing water shall not be lower than 20°F cooler than the surface temperature of the concrete at the time the water and concrete come in contact.

E. Curing Blanket: ASTM C171. Cellulose fabric sheets with an impervious layer on one side. Conkure by Raven Industries, UltraCure by Sika Industries.

F. Curing Paper: ASTM C171, regular or white waterproof paper.

2.2 FINISHING MATERIALS

A. Slab Sealer:
1. Silane or Siloxane based 96% chloride ion screen
2. Do not apply to surfaces cured with curing compounds,
3. Acceptable products:
    a. Euco-Guard-100 by Euclid Chemical
    b. SikaGard 701W by Sika Corporation
    c. Starseal EF Weather Seal Plus by Vexcon
    d. Or equivalent

B. Evaporation Retardant:
1. Water based polymer liquid evaporation retardant
2. Acceptable products:
    a. E-CON as manufactured by L&M Construction Chemicals, Inc.
    b. SikaFilm by Sika Corporation
    c. Confilm by Master Builders
    d. Or equivalent

2.3 REPAIR MATERIALS

A. Grout Paint: Mix 1 part Portland cement, 1 part fine sand, and enough water to the consistency of thick paint.

B. Patching Mortar: 1 part of a mixture of white and grey portland cement to 2.5 parts of damp loose sand. Cement type to match substrate.

C. All repair materials in contact with potable water shall be NSF Standard 61 approved.

D. Epoxy Adhesive:
   1. Two- or three-part water based epoxy bonding agent with cementitious components
   2. Acceptable products:
      a. Armatec 110 Epocem by Sika Corporation
      b. Corr-Bond by Euclid Chemical Co.
      c. MasterEmaco P 124 by Master Builders
      d. Or equivalent

E. Repair of random cracks (dry – free of liquid or moisture):
   1. 2-component, 100% solids, moisture-tolerant, low-viscosity, high-strength, multipurpose, epoxy resin adhesive.
   2. Acceptable products:
      a. Sikadur 35 Hi-Mod LV by Sika Corporation
      b. Eucopoxy Injection Resin by Euclid Chemical Co.
      c. MasterInject 1500 by Master Builders
      d. Or equivalent

F. Repair of random cracks (wet - presence of liquid or moisture):
   1. Low viscosity polyurethane resin that expands and forms a closed cell foam when it comes in contact with water.
   2. All cracks that are wet (either damp or leaking) at the time of repair shall be repaired with a material that is specifically intended for wet repair as recommended by the manufacturer.
   3. Acceptable products:
      a. SikaFix HH Hydrophilic by Sika Corporation
      b. Dural Aqua-Fil by Euclid Chemical Co.
      c. MasterInject 1210 IUG by Master Builders
      d. Or equivalent

G. Repair of excessive cracking:
   1. Two component, 100% solids, moisture-tolerant, epoxy or urethane crack healer / penetrating sealer
   2. Acceptable products:
      a. Sikadur 55 SLV by Sika Corporation
      b. Euco Qwikstitch by Euclid Chemical Co.
      c. MasterSeal 370 by Master Builders
      d. Or equivalent

H. Repair of spalls, honeycombs areas and air voids and cementitious overlays:
   1. Polymer modified, non-sag cementitious repair mortar with corrosion inhibitor.
   2. Repair material shall include peastone for repairs of greater depth as required by the manufacturer. For repair areas involving depths generally in excess of three (3) inches, utilize a repair material suitable for the depth of repair.
   3. Acceptable products:
      a. SikaTop 122 Plus or 123 Plus by Sika Corporation
      b. Tamms Structural Mortar by Euclid Chemical Co.

c. MasterEmaco N 400 MasterEmaco N 400
d. Or equivalent

I. All repair materials shall be installed in accordance with the manufacturer's recommendations.

PART 3 - EXECUTION

3.1 FINISHES

A. Repair all defects and allow repair material to properly cure prior to finishing concrete.
B. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete.
C. Finish concrete surfaces as scheduled.

3.2 SLABS AND FLATWORK FINISHES

A. Screed to bring concrete surface to proper contour and elevation.
B. Highway straightedge, bull float or darby float the concrete surface immediately after screeding.
C. Allow bleeding process to complete and for all bleed water to evaporate. Slabs shall not be finished while bleed water is on the surface. Means to accelerate drying such as applying dry cement, sand, and other materials shall be prohibited.
D. The specified evaporation retardant may be used a finishing aid to control plastic shrinkage cracking. Conditions that may warrant its use include high temperature, low humidity, high winds, and direct sunlight.
E. Where a dry shake application of cementitious waterproofing is applied, it shall be incorporated into the finishing operation.
F. After completion of the above listed procedures, provide one of the concrete finishes listed below as indicated in the Schedule of Finishes:
    1. (FF) Float Finish: Float the surface with magnesium or cast aluminum float or with a power finishing machine. Floating shall begin when the water sheen has evaporated and when the slab has stiffened sufficiently to allow proper operation of a power-driven float. Hand floating with wood, aluminum or magnesium floats shall be used at locations inaccessible to a power float.
    2. (LTF) Light Trowel Finish: Provide Float Finish. Apply trowel with a minimum number of passes to provide a sealed surface free of trowel marks. Do not apply an excessive number of trowel passes.
    3. (HTF) Hard Trowel Finish: Provide Float Finish. Steel trowel surface immediately after floating to produce smooth surface. Steel trowel again after concrete has hardened enough so that mortar does not adhere to trowel edge. Ringing sound should be apparent when performing second troweling due to tilted, compacting motion. The finished surface shall be free of trowel marks and uniform in texture and appearance.
    4. (WFF) Wood Float Finish: Allow concrete to stiffen. Use wood float to provide even surface with open pores.

5. (LBF) Light Broom Finish: Provide FF or WFF as indicated above. While plastic draw a soft-bristled broom, over the concrete in long even strokes with downward pressure. Broom transverse to traffic or at right angles to the slope of the slab.
6. (SF) Scratch Finish: Roughen the surface with stiff brushes or rakes before final setting. Remove laitance and loose aggregate.

3.3 VERTICAL SURFACE FINISHES

A. Surface tolerance classes indicated herein are specified in ACI 117, and include abrupt surface irregularities that are measured within 1-inch of the irregularity, and gradual surface irregularities measured as the maximum gap between the concrete and the near surface of a 5-foot straight-edge, measured between contact points.

B. Surface Finish-1.0 (SF-1.0):
1. Patch voids larger than 1 ½ inches wide or ½ inch deep.
2. Projections exceeding 1 inch in height shall be removed.
3. Form tie holes need not be patched.
4. Repair surface and structural defects as indicated in this Section.
5. Surface tolerance Class D with formed surface irregularities not more than 1 inch.

C. Environmental Surface Finish-1.0 (ESF-1.0):
1. Patch voids larger than 1 ½ inches wide or ¼ inch deep.
2. Projections exceeding ½ inch height shall be removed.
3. Patch form tie holes.
4. Repair surface and structural defects as indicated in this Section.
5. Surface tolerance Class C with formed surface irregularities not more than ½ inch.

D. Environmental Surface Finish-2.0 (ESF-2.0):
1. Patch voids larger than ¾ inch wide or ¼ inch deep.
2. Projections exceeding ¼ inch in height to be removed.
3. Patch form tie holes.
4. Repair surface and structural defects as indicated in this Section.
5. Surface tolerance Class B with formed surface irregularities not more than ¼ inch.

E. Environmental Surface Finish-3.0 (ESF-3.0):
1. The concrete surface shall be of uniform color, texture.
2. The arrangement of the facing material shall be orderly and symmetrical, with the number of seams kept to the minimum.
3. Patch voids larger than ½ inch wide or ¼ inch deep.
4. Projections exceeding 1/16 inch in height to be removed.
5. Patch form tie holes.
6. Repair surface and structural defects as indicated in this Section.

F. Grout-Cleaned Rubbed Finish (GCRF):
1. Within 48 hours of form removal, Provide an ESF-3.0 finish as specified above, and complete a grout-cleaned rubbed finish as described below.
2. The wall surface shall have all loose dirt, scale, etc. removed.

3. The surface shall be wetted and allowed to soak the surface. The surface being worked on shall not be in the sun while finishing. Curing in the sun is acceptable.
4. The grout mixture shall be one-part Portland cement and 1 ½ parts sand (by volume) and enough water to produce the consistency of thick paint matching the color of the surrounding concrete. After the materials are mixed, let set for at least 15 minutes.
5. The sand and portland cement shall be obtained from the concrete plant where the concrete was obtained and shall be the same sand and the same cement as used in the concrete.
6. Scrub grout into voids and remove excess grout.

3.4 MISCELLANEOUS CONCRETE SURFACE

A. Curbs: Provide steel trowel finish to top surface. Strip forms immediately after 24 hours and apply an ESF-3.0 finish to vertical surfaces.
B. Top of walls:
   1. Exposed to view - Strike off smooth and hand steel trowel to produce a smooth hard level surface. Line and elevation shall be pre-established by means of preset wood screeds which shall be removed during the troweling operation.
   2. Not exposed to view – Strike off smooth.

3.5 SLAB SEALER

A. Apply in strict conformance to manufacturers' recommendations. The requirements indicated below are minimum and more stringent requirements required by the manufacturer shall be adhered to
B. Cure concrete as specified. Let concrete age for a minim of 30 days prior to application of sealer.
C. Clean surface of oil, grease, dirt, and foreign materials as recommended by the manufacturer.
D. Apply when slab temperature is between 40°F and 80°F.

3.6 CURING

A. Curing: Curing shall begin immediately following the initial set of concrete or after slab surface finishing has been completed when it will not mar, erode or stain the concrete surface and shall continue after form removal. All concrete shall be cured to attain strength and durability by one of the following methods for a minimum of 7 consecutive days immediately after placement. See Schedule of Finishes and Curing Requirements in this Section:
   1. Moist Cure
      a. Ponding or continuous sprinkling. Intermittent wetting and drying is not an acceptable curing method.
      b. Application of curing blankets kept continuously wet.

c. Application of curing paper kept continuously wet. Use wet methods for the first 24 to 30 hours. Lap side joints of paper 4 inches minimum and end joints 6 inches minimum. Tape joints or weigh down paper to prevent displacement. Repair any and all tears during the curing period. Apply paper no earlier than 24 hours, and no later than 30 hours, after finishing. The slab surface shall be maintained in a wet condition beneath the paper at all times.

d. Contractor shall provide additional heat as required to maintain moist curing.

2. Application of concrete curing compounds.

a. When using dissipating resin curing compounds, allow curing compound to chemically break-down, and remove residuals and other foreign material, prior to applying sealers and other coatings.

b. The use of non-dissipating resin curing compounds on surfaces to receive toppings, sealers, chemical hardeners, water repellents, coatings, or a rubbed or bonded finish is not allowed. Utilize curing methods as indicated in the Schedule in part 3.7.

c. For slabs, apply immediately following the disappearance of the surface water sheen after the final finishing pass. For formed concrete, apply immediately after form removal.

B. Moisture loss from surfaces placed against wooden or metal forms exposed to heating by the sun shall be minimized by keeping the forms wet until they can be safely removed.

C. After form removal of vertical elements, the concrete shall be cured as indicated in the Table below for the balance of time remaining as specified above. All exposed concrete (tops of walls) within vertical forms shall begin curing within 24 hours of placement, regardless of the duration that the forms will remain in place.

D. Cold Weather:

1. Unless otherwise superseded by more stringent requirements within this Specification, conform to ACI 306.1 for placement of concrete in cold weather as defined in Part 1.6.

2. Thermal protection must be provided immediately after concrete placement. Procedures for covering, insulating, housing and/or heating concrete shall be prearranged. Except when supplemental heat is provided, the R-value of the insulation shall be in accordance with the recommendations of Chapter 9 of ACI 306R.

3. Concrete structures shall be covered, insulated and heated as required to protect the concrete prevent frost penetration beneath the structures.

4. Maintain concrete at the following minimum temperature (measured at concrete surface) for a minimum protection period of 7 days:

a. Sections of less than 12 inch minimum dimension: 55°F

b. Sections of 12 to 36 inch minimum dimension: 50°F

c. Sections of 36 to 72 inch minimum dimension: 45°F

d. Sections greater than 72 in minimum dimension: 40°F

5. Protect concrete from damage due to concentrated heat sources to minimize local carbonation of the concrete surfaces. Combustion heaters shall be located so they do not apply heat directly to the concrete surfaces.
6. For those surfaces requiring curing compounds, reapply curing compounds every two days during heating period or at greater frequencies as required by the manufacturer.
7. The temperature shall be monitored at the surface of the concrete, including corners and edges, which are more vulnerable to low temperature. The concrete surface temperature shall be recorded a minimum of twice per each 24 hour period.
8. Slabs, regardless of air content, shall not be exposed to freezing temperatures when exposed to rain, snow or other water sources, prior to reaching a compressive strength of 3500 psi.
9. Concrete shall be cooled gradually at the end of the protection period. The maximum allowable temperature drop at the concrete surfaces during the first 24 hours after the end of the curing period shall not exceed 5°F in any 1 hour and shall not exceed the following total temperature drop in the first 24 hours:
   a. Sections of less than 12 inch minimum dimension: 50°F
   b. Sections of 12 to 36 inch minimum dimension: 40°F
   c. Sections of 36 to 72 inch minimum dimension: 30°F

E. Hot Weather:
1. Unless otherwise superseded by more stringent requirements within this Specification, conform to ACI 308.1 for curing of concrete in hot weather as defined in Part 1.6.
2. Protect concrete from plastic shrinkage cracking and rapid evaporation of water.
3. Shade concrete from direct sun and protect from wind.

3.7 INSTALLATION OF CONCRETE FILL

A. Clean surface with brooms, water jets or air jets. Maintain wet for 6 hours immediately before placing fill concrete. Remove all standing water.
B. Immediately before placing concrete fill, broom in grout paint to the damp concrete surface. Do not allow grout paint to set prior to placement of concrete fill.
C. Clarifiers: Screed concrete fill to a true surface using the scrapers of the installed mechanical equipment to the depth shown on the Drawings.
D. Apply finish in accordance with Schedule.

3.8 SCHEDULE OF FINISHES AND CURING REQUIREMENTS

A. Concrete surfaces "exposed to view" shall be defined as those exposed to view upon completion of the Work, whether or not a painted finish is specified. Surfaces which will be covered by fill, such as exterior faces of walls, shall not be considered exposed to view. Interior surfaces of tanks and channels to receive a cover (including grating), or that are more than one foot below the design water level, shall not be considered exposed to view.

B. Provide finishes on concrete surfaces according to the following schedule:

SCHEDULE OF FINISHES AND CURING REQUIREMENTS		
Location	**Finish**	**Curing Requirements**
WALLS AND VERTICAL SURFACES		
Non Liquid Retaining		
Exterior surfaces exposed to view from top of walls to 6" below grade	ESF-3.0	Moist cure
Frost walls	SF-1.0	Moist cure or apply curing and sealing compound
Curbs	ESF-3.0	Moist cure or apply curing and sealing compound
Liquid Retaining or Containment		
Exterior surfaces exposed to view	ESF-3.0 then GCRF	Moist cure
Exterior below grade surfaces not exposed to view	ESF-2.0	Moist cure
Interior surfaces	ESF-3.0	Moist cure
SLABS, BEAMS AND CONCRETE FILL		
Buildings		
Interior slabs that will not receive an Architectural Finish, topping or coating	LTF	Moist cure
Slabs that will receive an Architectural Finish	LTF	Moist cure
Undersides of elevated slabs	ESF-3.0	N/A
Equipment pads	FF	Moist cure
Other Exterior Slabs		
Exterior slabs-on-ground	LBF	Moist cure and apply slab sealer
Exterior stairs, platforms, sidewalks and drives	LBF	Moist cure and apply slab sealer

NOTES:

1. An Architectural Finish is defined as a paint, tile, carpeting or other aesthetic wall or floor finish that is specified in Part 9 of the Contract Documents.
2. All concrete to receive a coating, slab sealer, dampproofing, topping, or Architectural finish shall be moist cured.

3. All applied curing, sealing and hardening materials shall be applied in a minimum of 2 coats or more if required by the manufacturer. Each successive coat shall be applied perpendicular to the previous coat.
4. Liquid retaining shall be defined as those slabs and walls which contain liquid or will be exposed to groundwater.
5. A tank is defined as any liquid retaining structure and includes tanks, channels, pits, chambers and any other structure that retains liquids.

3.9 REPAIRS TO CONCRETE (GENERAL)

A. Definitions:
   1. Honeycombed areas: Areas where voids are left in the concrete due to inadequate vibration and consolidation resulting in a failure of the mortar to effectively fill the spaces among coarse aggregate particles.
   2. Spalls: Concrete that has chipped, flaked, scaled or broken off from the surface of the concrete.
   3. Surface Defects: Those defects that affect the appearance of the finished concrete but do not affect the structural integrity. Surface defects include
   4. Structural Defects: Those defects that affect the appearance of the finished concrete and the structural integrity. Structural defects include:

B. Surface Defects:
   1. Form tie holes
   2. Air voids (bugholes)larger than those specified for the required surface finish
   3. Honeycomb areas with a depth less than 1 inch
   4. Blisters
   5. Delaminations
   6. Crusting
   7. Visible construction joints, fins and burs
   8. Non-uniform concrete color and appearance
   9. Floors that are not level

C. Structural Defects:
   1. Random cracks
   2. Excessive cracking (crazing)
   3. Spalls
   4. Air voids (bugholes) and honeycombed areas with a depth greater than or equal to 1 inch

D. All repairs to newly placed concrete shall be at no additional cost to the Owner.

3.10 REPAIR OF SURFACE DEFECTS

A. As soon as the forms have been stripped and the vertical concrete surfaces exposed or concrete slabs have been finished and cured, repair all surface defects. All concrete repair work shall result in a concrete surface of uniform color and texture, and shall be free of all irregularities.

B. Form Tie Holes: After cleaned and thoroughly dampened, apply grout paint and fill holes solid with patching mortar.

C. Air voids (bugholes): After cleaned and thoroughly dampened, apply grout paint and fill holes solid with patching mortar.

D. Honeycomb areas:
   1. All honeycombed areas shall be removed to sound concrete by means of hand chisels or pneumatic chipping hammers or hydrodemolition.
   2. Saw cut a 1 inch minimum square groove around the edges of the defective area perpendicular to the surfaces to serve as the boundary for concrete removal. Saw cut the edges perpendicular to the surface. No feather-edges shall be allowed.
   3. Remove all loose aggregate paste and debris and scrub clean. Thoroughly wet area to be repaired. Brush and scrub grout paint into the substrate of the area to be repaired.
   4. Mix patching mortar using as little water as possible. Allow to stand with frequent manipulation of trowel to achieve stiffest consistency. Blend white and gray portland cement to achieve color match with surrounding concrete.
   5. Prior to the set of grout paint (but after it has cast its water sheen), apply a stiff consistency of patching mortar to the area with a trowel. Leave patched surface slightly higher than surrounding surface. Do not finish for 1 hour minimum. Cure in same manner as adjacent concrete.

E. Blisters, delaminations and crusting: Repairs shall be similar to those for honeycomb areas. Depth of saw cut shall match the depth of the defective concrete.

F. Visible construction joints, fins and burrs: Remove by grinding until a smooth uniform surface is attained.

G. Concrete with an overall non-uniform color or appearance as determined by the Engineer shall be repaired with a complete cementitious overlay. Application of the overlay shall be in strict accordance with the manufacturer's written instructions and recommendations.

H. Finished Flatwork exceeding specified tolerances:
   1. High areas shall be repaired by grinding after the concrete has cured 14 days.
   2. Low areas shall be repaired by adding appropriate overlay material. Grind concrete if required to provide minimum overlay thickness as required by the manufacturer. Finish repair area to match adjacent concrete.

3.11 REPAIR OF STRUCTURAL DEFECTS

A. Remove and replace or repair all structural defects in newly placed concrete.

B. Repair all structural defects in existing concrete that are identified by the Engineer during construction. These repairs are identified either on the Structural Drawings or in the Bid Form.

C. Unless otherwise indicated, all concrete defects shall be repaired in accordance with the specific repair material manufacturer's recommendations.

D. Random cracks:
   1. Cleaning of cracks:
      a. Dry cracks: Crack or void must be dry at time of application. Remove all dust, debris or disintegrated material from cracks or voids by the use of oil-free compressed air or vacuuming. Cracks saturated with oil or grease must be chipped out to unsaturated concrete. "Vee" out cracks in horizontal surfaces slightly.

b. Wet cracks: Clean the crack surface so that the crack can be located. If the crack is wide or high-water flows are encountered, seal the surface of the crack with a surface sealing material as recommended by the manufacturer.

2. Where cracks extend through members and are accessible, seal bottom of crack which is to receive the repair material.
3. Patching of vertical wall or overhead cracks shall be accomplished in the same manner using a similar epoxy material of higher viscosity as recommended by the manufacturer.
4. Apply repair material in strict accordance with manufacturer's recommendations.

E. Excessive cracking (Crazing):
1. Floor slabs containing an excessive amount of cracks as defined herein, and which will remain exposed, shall receive topping after sealing of cracks in accordance with the above paragraph.
2. Excessive cracking shall be defined as areas containing cracks averaging 1/64th-inch wide or greater, and in excess of 15 linear feet of cracks per 100 square feet of slab. In the event that excessive cracking occurs in isolated areas of a given floor, topping shall only be applied in the area of the cracks bounded by construction, expansion, or control joints.
3. Apply repair material in strict accordance with manufacturer's recommendations.

F. Spalls and honeycomb areas:
1. All weakened, damaged or disintegrated concrete shall be removed to sound concrete by means of hand chisels or pneumatic chipping hammers or hydrodemolition.
2. Saw cut a 1 inch minimum square groove around the edges of the defective area perpendicular to the surfaces to serve as the boundary for concrete removal. Saw cut the edges perpendicular to the surface. No feather-edges shall be allowed.
3. Remove defective concrete. If defective areas extend around reinforcing steel, chip to provide a clear space of at least 1 inch all around the bar. When pneumatic chipping hammers are used for removal of concrete around reinforcement, they shall not exceed 15 pounds.
4. Apply repair material in strict accordance with manufacturer's recommendations.

3.12 MODIFICATIONS TO EXISTING CONCRETE

A. When removing materials or portions of existing structures and when making openings in existing structures, all precautions shall be taken and all necessary barriers, temporary bracing and shoring and other protective devices shall be erected to prevent damage to the structures beyond the limits necessary for the new work and to prevent damage to the structures or contents by falling or flying debris.

B. Remove concrete to the depths shown or required. Surfaces must be clean and sound. Remove dust, laitance, grease, curing compounds, impregnations, waxes, foreign particles, and disintegrated materials. Clean surface of all contamination and debris, and roughen by steel shot-blasting, abrasive (sand) blasting, or water-jetting (hydrodemolition). Use of scabblers, scarifiers, bush hammers, or pneumatic hammers is not permitted. The prepared surface shall be water-saturated for a minimum of six hours, and the excess water shall be removed immediately prior to placement of repair material.

C. Exposed reinforcement shall be cleaned by wire brushing, steel shot blasting or abrasive sand blasting. Reinforcement shall be cut or bent as shown on the Drawings. Additional reinforcement shall be provided as shown on the Drawings.

3.13 CORING OF HOLES

A. Core drill holes only where shown. Prior to coring holes in existing concrete, Contractor shall coordinate with the Owner and Engineer to determine the location of existing utilities in the concrete.

B. Coring shall be performed with a non-impact rotary tool with diamond core drills, size shall be suitable for pipe conduit, sleeves or mechanical seals to be installed. Protect all existing equipment, utilities and critical areas against water or other damage caused by the drilling operation.

C. No additional structural members shall be cut without review by the Engineer with no exceptions taken.

D. Apply epoxy paint (5 mils DFT minimum) to exposed reinforcing cut during coring that will not be covered with new concrete or repair material.

3.14 CUTTING OF HOLES

A. Prior to cutting holes in existing concrete, Contractor shall coordinate with the Owner and Engineer to determine the location of existing utilities in the concrete.

B. Cutting shall be done with a concrete wall saw and diamond saw blades of proper size.

C. Provide for control of slurry generated by sawing operation on both sides of wall.

D. When cutting a reinforced concrete wall, the cutting shall be done so as not to damage the bond between the concrete and reinforcing steel left in structure.

E. New openings in existing concrete shall be overcut and formed as follows:

1. The opening size removed shall be a minimum 4" greater on each side, unless otherwise indicated on the Drawings.
2. The concrete shall be saw cut to the limits indicated.
3. While removing the concrete, either:
    a. Maintain the existing reinforcing steel such that it extends 2" beyond the cut.
    b. Cut the existing reinforcing steel flush with the cut concrete. Prior to placing the new concrete to form the new openings, drill and adhere reinforcing steel dowels into the existing concrete with high strength epoxy as indicated on the drawings.
4. Apply an epoxy bonding adhesive to the cut concrete surface. Apply surface applied waterstop if indicated on the Contract Drawings

5. Add additional reinforcing steel and place new concrete to form the new opening as indicated.

3.15 PROTECTION

A. In addition to providing protection against hot and cold weather, provide the following additional protective measures for freshly placed concrete:
   1. Protect concrete against vibration until concrete has attained 33% of its 28-day strength. Do not compact soil, or blast ledge within 100 feet of freshly placed concrete until concrete has attained 33% of its 28-day strength.
   2. Protect concrete against premature loads until the concrete has been in place for 28 days and the design strength has been attained (unless otherwise indicated). Premature loads include but are not limited to:
      a. Backfilling
      b. Loading slabs
      c. Building CMU walls atop slabs
      d. Installing equipment on slabs
      e. Installing equipment atop slabs prior to completion of backfilling

END OF SECTION

SECTION 03420

PRECAST CONCRETE STRUCTURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Precast concrete structures:
   1. All circular precast concrete structures with a size greater than or equal to 6'-0" interior diameter (sections assembled vertically). Smaller sections are specified in Division 2.
B. Joint sealants
C. Leak testing

1.2 RELATED SECTIONS

A. Section 01340 - Submittals
B. Section 02601 - Manholes, Covers and Frames
C. Section 08305 - Special Doors

1.3 REFERENCES

A. This section contains references that are applicable to this Specification Section. The applicable edition of the indicated references shall be the version that was the most current at the time of the Advertisement of Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued, or replaced.
B. ACI 117 – Specifications for Tolerances for Concrete Construction and Materials
C. ACI 301 Specifications for Structural Concrete
D. ACI 318 Building Code Requirements for Structural Concrete
E. ACI ITG -7 – Specification for Tolerances for Precast Concrete
F. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
G. ASTM A153/A153M – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
H. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
I. ASTM A1064/A1064M – Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain or Deformed, for Concrete
J. ASTM C33/C33M – Standard Specification for Concrete Aggregates
K. ASTM C40/C40M – Standard Test Method for Organic Impurities in Fine Aggregates for Concrete

L. ASTM C88– Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
M. ASTM C94/C94M – Standard Specification for Ready-Mixed Concrete
N. ASTM C131/C131M – Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Abrasion Machine
O. ASTM C150/C150M – Standard Specification for Portland Cement
P. ASTM C260/C260M – Standard Specification for Air-Entraining Admixtures for Concrete
Q. ASTM C478 - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
R. ASTM C494/C494M – Standard Specification for Chemical Admixtures for Concrete
S. ASTM C535 – Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Abrasion Machine
T. ASTM C595/C595M – Standard Specification for Blended Hydraulic Cements
U. ASTM C618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
V. ASTM C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
W. ASTM C858 – Standard Specification for Underground Precast Concrete Utility Structures
X. ASTM C877 - Standard Specification for External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections
Y. ASTM C890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
Z. ASTM C913 – Standard Specification for Precast Concrete Water and Wastewater Structures
AA. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals
BB. ASTM C989/C989M – Standard Specification for Slag Cement for Use in Concrete and Mortars
CC. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
DD. ASTM C1240 – Standard Specification for Silica Fume Used in Cementitious Mixtures
EE. ASTM C1260– Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
FF. ASTM C1293– Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction
GG. ASTM C1567– Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar Bar Method)
HH. ASTM C1602/C1602M – Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Production

II. ASTM D1187/D1187M - Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal
JJ. ASTM D1227/D1227M - Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing
KK. ASTM D4101 - Standard Specification for Polypropylene Injection and Extrusion Materials
LL. ASTM E329– Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction
MM. AWS D1.4/D1.4M – Structural Welding Code – Reinforcing Steel
NN. Concrete Reinforcing Steel Institute - 10MSP, Manual of Standard Practice
OO. AASHTO HB-17, Standard Specifications for Highway Bridges (17th Edition)
PP. Precast/Prestressed Concrete Institute (PCI) – Manual for Quality Control for Plants and Production of Structural Precast Concrete Products (MNL-116)

1.4 DESIGN REQUIREMENTS

A. All precast units shall be constructed of the shapes and sizes as shown on the Drawings, with interlocking ship lap joints.
B. All base sections shall be designed and constructed with the floor slabs cast as an integral placement with the bottom wall section.
C. In addition to the requirements specified herein, all precast units shall meet the following:
    1. Circular units shall meet ASTM C478.
D. Structural design calculations shall be in accordance with ACI 318 “load and resistance factor design” and include the following loading conditions:
    1. For all load cases, the weight of soil shall be taken as 125 pounds per cubic foot.
    2. Rectangular or square utility structures shall be designed to the requirements of ASTM C857, except using lateral earth pressure coefficient of 0.50 and AASHTO HS-25 vehicle load.
    3. Rectangular or square water and wastewater structures shall be designed to the requirements of ASTM C890, except using lateral earth pressure coefficient of 0.50 and AASHTO HS-25 vehicle load.
    4. The following load cases shall be included for all structures, including those designed to the requirements of ASTM C857, ASTM C890, and ASTM C478:
        a. For all structures:
            i. Empty structure with cumulative maximum external vertical and horizontal loads including lateral earth pressure, maximum groundwater elevation, and lateral vehicle surcharge.
            ii. Empty structure with cumulative maximum external vertical loads and half the maximum lateral earth pressure, no groundwater, and no lateral vehicle surcharge.
            iii. The forces and distortions applied during curing, stripping, storage, transportation, lifting and erection so that precast members are not overstressed or otherwise damaged.
    5. Unless otherwise indicated on the Drawings, the maximum groundwater level shall be assumed at finished grade or the flood elevation noted on the Drawings, whichever is higher.

E. Concrete admixture for microbiologically induced corrosion control shall be included.

F. Reinforcing Steel:
   1. Forflat slab tops and bases of circular structures: the minimum steel reinforcement in each direction in slabs and walls shall not be less than 0.0025 times the gross area of the concrete section.

G. Concrete clear cover on reinforcing steel: 1½ inches minimum.

H. The interior dimensions of the precast concrete structures shall be as shown on the Drawings. Walls, top slabs and base slabs shall be a minimum of 8" thick.

I. The precast concrete structure shall be designed to resist flotation:
   1. A factor of safety of 1.15 shall be used against flotation based on weights of empty structure and soil directly over footing extensions and above the top slab (if any).
   2. Unless otherwise indicated on the Drawings, the maximum groundwater level shall be assumed at finished grade or flood elevation indicated on the Drawings.
   3. The base slab may be extended beyond the face of the wall to provide additional resistance to flotation.
   4. Unless otherwise indicated on the Drawings, additional cast-in-place concrete base slabs will not be permitted for flotation resistance.
   5. Frictional resistance shall not be permitted.
   6. Where the structure is composed of successive vertical segments, the weight of the segments shall be such as to provide the same factor of safety for buoyancy, or stainless-steel mechanical connections shall be used to connect the segments together. The design shall also include such anchorage to the reinforced concrete anti-buoyancy slab, if such slab is indicated on the Drawings.
   7. The buoyant force acting on an object is equal to the weight of the volume of water that is displaced by the object. The actual weight of the same volume determines whether or not the object is buoyant.
   8. If the Engineer determines that the submitted buoyancy calculations are incorrect, the Engineer shall direct the Contractor to implement specific measures to counteract buoyancy to the Engineer's satisfaction. Any and all costs associated with such measures shall be borne entirely by the Contractor and shall be at no additional cost to the Owner.

J. Segmental structure joints:
   1. Provide waterstop sealants and external sealing bands in all joints to create watertight joints.

1.5 SUBMITTALS

A. Manufacturer's Data:
   1. Submit manufacturer's specifications and instructions for all manufactured materials and products including hatches, sealants, sealing bands, dampproofing, pipe sleeves, flexible wall boots, anchorage hardware and other items. Include manufacturer's certifications and laboratory test reports as required.
   2. Submit the proposed erection procedure for precast units, sequence of erection, and required handling equipment.

B. Shop Drawings:
   1. Submit shop drawings showing complete information for the fabrication and installation of precast concrete units.
   2. Submit layout drawings prepared and stamped by a Professional Engineer registered in the State of New Hampshire. Drawings shall include the following information:
      a. Overall layout drawings of the assembled precast concrete including overall dimensions. Provide identification of each precast unit corresponding to the sequence and procedure of installation.
      b. Drawings of individual members indicating plan and cross section dimensions, locations, sizes, types and details of reinforcement.
      c. Location and details of anchorage devices that are to be embedded in the precast concrete sections.
      d. Locations and details of joints including ship laps and details of mechanical connections.
      e. Locations of wall penetrations for pipes. All openings shall be cast-in-place at the manufacturing plant. Field coring of pipe penetrations shall not be allowed.
   3. Submit structural design and buoyancy calculations. Calculations and Drawings shall be prepared and stamped by a Professional Engineer registered in the State of New Hampshire. Calculations will be reviewed for consistency with the project intent only. The Professional Engineer stamping the shop drawings and calculations shall be responsible for the design.
   4. Submit Concrete Mixture designs including test data that meets the criteria specified in ACI 301, Section 4. Mixture design shall include:
      a. Proportions for all ingredients, 28-day design compressive strength, water to cementitious materials ratio, admixture dosages, slump, and air content.
      b. Cement Manufacturer's Certificates of conformance with ASTM C150/C150M or C595/595M taken during the last 90 days.
      c. Supplementary Cementitious Materials: Source and test reports with certificates of conformance with ASTM C618 for fly ash and ASTM C989/C989M for slag cement for actual material to be used in the Work taken during the last 90 days
      d. Aggregate: data not older than 90 days, except test data for soundness, abrasion, alkali reactivity – not older than 12 months. Fine and coarse aggregate data shall include:
         i. Sources
         ii. Specific Gravity
         iii. Sieve analyses per ASTM C33/C33M, including fineness modulus of fine aggregate or shall meet FDOT requirements for structural concrete
         iv. Organic impurities for fine aggregate per ASTM C40/C40M
         v. Aggregate reactivity (fine and coarse aggregate), one of the following options:
            (1) Aggregate test data in accordance with ASTM C1293,
            (2) Concrete mixture tests in accordance with ASTM C1567,

(3) Categorized in accordance with ASTM C1778 with testing in accordance with ASTM C1293 at 1-year, or ASTM C1260 at 16-days if ASTM C1293 test data is not available. Also indicate the total alkali loading contributed by portland cement in the submitted mixture/s.

vi. Soundness per ASTM C88 tested with magnesium sulfate (fine and coarse aggregate).

vii. Abrasion for coarse aggregate per ASTM C131/C131M or ASTM C535 (coarse aggregate).

e. Product data and material safety data sheets for concrete admixtures.

i. Microbiologically induced corrosion control (MICC) admixture.

(1) Product data, dosage, and instructions for use including storage, preparation prior to dosing, batching sequence, dosing process, and concrete mixing procedures.

(2) Letter from MICC admixture manufacturer attached to concrete mixture design stating that the concrete mixture design is compatible for use with the admixture. (MICC admixtures may not be compatible with some commercially available concrete admixtures.)

(3) Letter of certification from precaster stating that all requirements of the admixture manufacturer were followed.

(4) Concrete batch tickets for each batch of concrete, indicating inclusion of MICC admixture.

f. Test reports by testing agencies meeting ASTM E329:

i. Test data used to determine the standard deviation used for establishing the required average design strength, and test data documenting that the proposed concrete proportions will produce an average compressive strength equal or greater than the required average compressive strength, shall be from within the previous 12 months.

ii. Laboratory trial batch data shall be from with the previous 24 months.

5. Submit past Project list with Owner contact information.

6. Submit letter from precast concrete manufacturer stating:

a. That all segmental precast concrete structures have been shop assembled prior to shipment and all fabrication and construction and erection tolerances have been adhered to.

b. For segmental box type tank structures assembled horizontally include statement that adjacent sections have been marked at the plant with match points to facilitate field assembly and correct alignment, and have been dry fit assembled at the plant to confirm that the required fit is obtained at each joint.

c. For structures assembled vertically include statement that adjacent sections have been marked at the plant with match points to facilitate field assembly and correct alignment, and have been dry fit assembled at the plant to confirm that the required fit is obtained at each joint.

1.6 QUALITY ASSURANCE

A. The manufacturer shall exhibit satisfactory performance on projects of similar magnitude under similar or equal service conditions for a period not less than five (5) years.

B. For structures specified to meet ASTM C913 the concrete manufacturing plant shall be certified by the Precast/Prestressed Concrete Institute (PCI) Plant Certification Program for Group C1 products. For structures specified to meet ASTM C478 or ASTM C858, the concrete manufacturing plant shall be certified by the National Precast Concrete Association (NPCA).

C. The precast concrete manufacturing plant shall implement a Quality Control Plan and maintain a permanent Quality Control Manual outlining the quality control procedures used by the plant. The Quality Control Plan and Manual shall adhere to the requirements of MNL-116.

D. Engineer (or Independent Testing Laboratory) may perform a plant inspection at any time during casting of precast concrete components during the construction period. General Contractor shall notify the Engineer a minimum of 14 days prior to the availability of specific precast components for inspection. After notification, Engineer will notify the General Contractor a minimum of 72 hours prior to the inspection.

E. Segmental box type tank structures assembled horizontally: adjacent sections shall be marked at the plant with match points to facilitate assembly and achievement of correct alignment. Adjacent sections shall be dry fit assembled at the plant to confirm that the required fit is obtained at each joint prior to shipment to project site.

F. Structures assembled vertically: adjacent sections shall be marked at the plant with match points to facilitate assembly and achievement of correct alignment. Adjacent sections shall be dry fit assembled at the plant to confirm that the required fit is obtained at each joint prior to shipment to the project site.

1.7 WARRANTY

A. The Contractor shall provide a one (1) year warranty (from the Date of Substantial Completion) for the following:
   1. Cracking, spalling or other surface and structural defects.
   2. Separation of joints or misalignment of adjacent units due to faulty precast concrete sections.
   3. Leakage through all joints between concrete sections due to faulty materials or improper installation.
   4. Microbiologically induced corrosion.

B. The manufacturer shall repair or replace all defective work at no additional cost to the Owner within warranty period.

1.8 DELIVERY, STORAGE AND HANDLING

A. All materials shall be inspected at the project site by the General Contractor for surface and structural defects at the time of delivery. All damaged materials shall be replaced by the Contractor at no additional cost to the Owner.

B. Store precast concrete units at the project site to ensure against cracking, distortion, staining, or other physical damage, and so that markings are visible. Lift and support units at the designated lift points only.
C. All precast concrete units shall be placed on supports such that they are stored off the ground.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. American Concrete (Superior Concrete, LLC), Auburn, ME, PCI (B2, C1)
B. Unistress Corp, Pittsfield, MA, PCI (A1,B4,C4A)
C. Oldcastle Precast, Inc, Avon, CT, PCI (B2,C2,C2A)
D. Blakeslee Prestress, Inc., Branford, CT, PCI (A1,B4,C4,C4A)United Concrete Products., Inc., Yalesville, CT, PCI (B3,C2) NPCA
E. J.P. Carrara & Sons, Inc., Middlebury, VT, PCI (A1,B4,B4A,C3,C3A)
F. E. Dailey Precast, LLC, Shaftsbury, VT, PCI (A1,B3A,C3A)
G. Strescon Limited, Saint John, New Brunswick, Canada, PCI (A1,B4,C4A)
H. Fabcon Precast, LLC, Selkirk, NY, PCI (B3, C3A)
I. Fort Miller Co., Inc., Greenwich, NY, PCI (B1A, C1A)
J. Dura-Stress, Inc, Leesburg, FL, PCI (A1,B4,B4A,C4,C4A)
K. George R. Roberts, Sanford, ME, NPCA
L. Shea Concrete Products, Nottingham, NH, NPCA
M. Shea Concrete Products, Amesbury, MA, NPCA
N. Shea Concrete Products, Wilmington, MA, NPCA
O. Arrow Concrete Products, Granby, RI, NPCA
P. S.D. Ireland Concrete Construction Corp., Williston, VT, NPCA
Q. Or equivalent

2.2 MATERIALS

A. Concrete mixture design shall conform to the following:
    1. Minimum compressive strength of concrete at 28-days, (f'c) = 5000 psi.
    2. Maximum water/cement ratio = 0.42
    3. Cement for all units shall be:
        a. For wastewater structures: Type II or III portland cement conforming to ASTM C150/C150M or specified blended cements.
        b. For stormwater structures and for vault-type structures not containing wastewater: Type I, II, or III portland cement conforming to ASTM C150/C150M or specified blended cements.
        c. Blended cements: ASTM C595/595M (MS) types, excluding type IS (≥70). Do not use blended cements conforming to ASTM C595/595M if they contain cements conforming to ASTM C1157/C1157M.
    4. Supplementary Cementitious Materials:
        a. Slag Cement: ASTM C989/C989M - Grade 100 or 120.
        b. Silica Fume: ASTM C1240
        c. Fly Ash: ASTM C618 - Type F

5. The proposed mixture shall contain cementitious materials in the following proportions:
   a. Portland Cement - No less than 65% of the total by weight.
   b. Slag Cement - No greater than 35% of the total by weight.
   c. Fly Ash - No greater than 25% of the total by weight.
6. Entrained air content of concrete: 6% ± 1.5%. Air entrainment admixture shall conform to ASTM C260/C260M.
7. Admixtures:
   a. Low Range Water Reducer (pending verification of compatibility with MICC admixture): MasterPozzolith 210 by Master Builders/BASF; WRDA with HYCOL by GCP Applied Technologies; or equivalent meeting ASTM C494/C494M Type A.
   b. High Range Water Reducer (superplasticiser) (pending verification of compatibility with MICC admixture): Rheobuild 1000 or Glenium 3000 NS by Master Builders/BASF; Daracem 100 or ADVA 140M by GCP Applied Technologies; or equivalent meeting ASTM C494/C494M Type F.
   c. Air entraining agent (pending verification of compatibility with MICC admixture): MasterAir AE 200 by Master Builders, DAREX II AEA by GCP Applied Technologies; or equivalent meeting ASTM C260/C260M.
   d. MICC: Con^{mic}Shield, as manufactured by ConShield Technologies, Inc. or Xypex Bio-San C500, as manufactured by Xypex Chemical Corporation.
8. Aggregates
   a. Prohibited: crushed hydraulic cement concrete and recycled aggregate.
   b. Coarse aggregate shall consist of a well graded crushed stone or a washed gravel conforming to the requirements of ASTM C33/C33M as follows:

	PERCENT PASSING			
SIEVE	NO. 8 (3/8”)	NO. 67 (3/4”)	NO. 57 (1”)	NO. 467 (1 1/2”)
1-½ inch	-	-	100	95-100
1 inch	-	100	95-100	-
¾ inch	-	90-100	-	35-70
½ inch	100	-	25-60	-
3/8 inch	85-100	20-55	-	10-30
No. 4	10-30	0-10	0-10	0-5
No. 8	0-10	0-5	0-5	-
No. 16	0-5	-	-	-
No. 50		-	-	-

   c. Fine aggregate shall meet FDOT requirements for structural concrete or consist of washed inert natural sand, free from mineral or other coatings, soft particles, clay, loam, organic and other deleterious materials, conforming to the requirements of ASTM C33/C33M as follows:

SIEVE NO.	PERCENT PASSING
4	95 to 100
8	80 to 100
16	50 to 85
30	25 to 60
50	5 to 30
100	0 to 10
200	0 to 3.0

The Fineness Modulus shall be between 2.3 to 3.1. The percentage retained between any two consecutive sieves shall not exceed 45%.

d. Fine Aggregate testing: Perform the following tests on samples of the fine aggregate:
   i. Organic Impurities (ASTM C40):
      (1) Color of supernatant liquid above test sample tested in accordance with ASTM C40 shall not be darker than standard (Organic Plate No. 3/Gardner Color Standard No. 11).
      (2) Use of a fine aggregate failing when tested in accordance with ASTM C40 is not prohibited, provided that, when tested for the effect of organic impurities on strength of mortar, the relative strength at 7 days, calculated in accordance with ASTM C87, is not less than 95 %.
   ii. Soundness (ASTM C88):
      (1) Fine aggregate sample tested in accordance with ASTM C88 for five cycles using magnesium sulfate (not sodium sulfate) shall have a weighted average loss not greater than 18%.
   iii. Alkali Reactivity:
      (1) Use one of the following three options:
         (a) Test aggregate in accordance with ASTM C1293. Aggregate having an expansion less than 0.04% at 1-year is acceptable for use.
         (b) Test aggregate with the cementitious materials combination submitted in accordance with ASTM C1567. Aggregate having an expansion less than 0.10% at 16 days is acceptable for use.
         (c) Aggregate reactivity shall be categorized in accordance with ASTM C1778 with testing in accordance with ASTM C1293 at 1-year, or ASTM C1260 at 16-days if ASTM C1293 test data is not available. If the coarse and fine aggregates are of different reactivity, the level of protection shall be based on the more reactive aggregate. The alkali content contributed by the portland cement shall not exceed 4.0 lbs per cubic yard of concrete for moderately reactive aggregate and 3.0 lbs per cubic yard

of concrete for highly reactive aggregate. The use of very highly reactive aggregate shall not be permitted.

(2) Evidence of a satisfactory service record in lieu of testing for alkali reactivity is not permitted.

e. Coarse Aggregate testing: Perform the following tests on samples of the coarse aggregate:

i. Abrasion (ASTM C131/C131M or ASTM C535):

(1) Coarse aggregate shall be tested in accordance with either ASTM C131/C131M (aggregate smaller than 1 1/2") or ASTM C535(aggregate larger than ¾").

(2) Loss of the mass of the coarse aggregate by abrasion shall not exceed 50%.

ii. Soundness (ASTM C88):

(1) Coarse aggregate sample tested in accordance with ASTM C88 for five cycles using magnesium sulfate (not sodium sulfate) shall have a weighted average loss not greater than 15%.

iii. Alkali Reactivity:

(1) Use one of the following three options:

(a) Test aggregate in accordance with ASTM C1293. Aggregate having an expansion less than 0.04% at 1-year is acceptable for use.

(b) Test aggregate with the cementitious materials combination submitted in accordance with ASTM C1567. Aggregate having an expansion less than 0.10% at 16 days is acceptable for use.

(c) Aggregate reactivity shall be categorized in accordance with ASTM C1778 with testing in accordance with ASTM C1293 at 1-year, or ASTM C1260 at 16-days if ASTM C1293 test data is not available. If the coarse and fine aggregates are of different reactivity, the level of protection shall be based on the more reactive aggregate. The alkali content contributed by the portland cement shall not exceed 4.0 lbs per cubic yard of concrete for moderately reactive aggregate and 3.0 lbs per cubic yard of concrete for highly reactive aggregate. The use of very highly reactive aggregate shall not be permitted.

(2) Evidence of a satisfactory service record in lieu of testing for alkali reactivity is not permitted.

9. Water:

a. Potable, from a municipal water supply, or

b. Nonpotable water that meets ASTM C1602/C1602M and the following requirements:

i. Chlorides as Cl: 1000 ppm - tested by ASTM C114 or by #4500, Argentometric Method from "Standard Methods for the Examination of Water and Wastewater".

ii. Sulfate as SO4: 1500 ppm – tested by ASTM D516 or ASTM D4130.
iii. Equivalent alkalies (Na2O + 0.658 K2O): 300 ppm total alkali – tested by ASTM C114.
iv. Total inorganic solids by mass: 5000 ppm – tested by ASTM C1603.
v. Organic solids by mass: 300 ppm – tested by AASHTO T 26.
vi. pH: 4.0 to 9.0 – tested by AASHTO T 26.
vii. Presence of oil: none to slight – by visual observation.

B. Reinforcement:
1. Bars: ASTM A615/A615M Grade 60; deformed new materials. Cold-bent in accordance with CRSI 10MSP.
2. Welded wire fabric: ASTM A1064/A1064M. Flat sheets are required; rolls are not permitted.
3. Tie wire: ASTM A1064/A1064M, annealed.

C. Plates and inserts:
1. Plates:
a. Provide cast-in-place plates as shown on the Drawings. Plates shall be either:
i. ASTM A36/A36M, hot-dip galvanized in accordance with ASTM A123/A123M, or
ii. AISI Type 316 stainless steel.
2. Inserts:
a. Provide inserts as required for lifting, connections, etc.
i. ASTM A123/A123M or A153/A153M hot-dip galvanized, or
ii. AISI Type 316 stainless steel.

D. Pipe Openings:
1. Provide formed cast-in-place holes, cored holes, or cast-in sleeves.
a. Flexible rubber watertight connectors shall conform to ASTM C923.
i. Connectors shall either be cast into the concrete or fastened to the structure with stainless steel expansive sleeves.
ii. Pipes shall be fastened to the connector with stainless steel bands.
iii. Products:
(1) Kor-N-Seal (106-406 Series) by Trelleborg Pipe Seals
(2) PSX: Positive Seal by Press-Seal Corporation
(3) Z-Lok Connector made by A-Loc Products Inc.
(4) Or equal
b. Hot-dipped galvanized steel sleeves with a welded waterstop ring centered in the wall.
c. Expansive rubber and stainless steel ring to seal annular space between pipe and pipe opening.

E. Precast section joints:
1. Provide rubber sealant and wraps at all precast concrete section joints.
2. Rubber sealants:
a. Install solid, continuous flexible butyl rubber sealants in all joints to achieve watertight joints. Install a double row of joint sealants for every manhole joint.

b. Sealant shall conform to ASTM C990.
c. Sealant shall be sized such that it compresses a minimum of 50% within the joint.
d. Sealant shall maintain stability at all temperatures and not shrink or harden over time.
e. Acceptable products:
i. Kent Seal No. 2 by Hamilton Kent
ii. RN 101 Ram-Nek Joint Sealant by Henry
iii. EZ-STIK or PRO_STIK Butyl Sealant by Press-Seal Corporation
iv. Conseal CS-102 (CS-202 when the temperature during installation is less than 30˚F) by Concrete Sealants, Inc.
v. Or equal

3. Joint Wrap:
a. Wraps shall consist of two layers: a butyl joint wrap layer (30 mil) and an EPDM rubber backing layer (45 mil).
b. Wraps shall be 12” wide.
c. Install solid, continuous flexible butyl rubber wraps around the exterior face of all joints to achieve watertight joints.
d. Wraps shall conform to ASTM C877 Type III.
e. Acceptable products:
i. EZ-WRAP by Press-Seal Corporation
ii. ConSeal CS-212
iii. Or equal

F. Liquid Asphalt Dampproofing:
1. Apply a two-coat waterborne emulsified-asphalt dampproofing system for all below grade exterior wall surfaces:
2. First coat: Fiber free waterborne emulsified asphalt dampproofing conforming to ASTM D1187/D1187M (Type 1) and ASTM D1227/D1227M (Type 3, Class I). Hydrocide 600 by Sonneborn Building Products, Sealmastic Emulsion by W.R. Meadows, or equal.
3. Second coat: Waterborne emulsified asphalt dampproofing reinforced by long fibers conforming to ASTM D1187/D1187M (Type 1) and ASTM D1227/D1227M (Type 2, Class I). Hydrocide 700 by Sonneborn Building Products, Sealmastic Emulsion by W.R. Meadows, or equal.

G. Hatches: Provide hatches as shown on the Drawings. Integral hatches are furnished under this Section and specified in Specification Section 08305 "Special Doors".

H. Manhole covers and frames: Provide manhole covers and frames as shown on the Drawings. Integral manholes covers and frames are furnished under this Section, and specified in Specification Section 02601 Manholes, Covers and Frames.

I. Concrete Repair Materials:
1. Grout Paint: Mix 1-part Type II portland cement, 1-part fine sand, and enough water to the consistency of thick paint.
2. Patching Mortar: 1-part of a mixture of white and grey Type II portland cement to 2.5 parts of damp loose sand. Cement type to match substrate.

3. Epoxy Adhesive:
    a. Two or three-part water-based epoxy bonding agent with cementitious components
    b. Acceptable products:
        i. Armatec 110 Epocem by Sika Corporation
        ii. Corr-Bond by Euclid Chemical Co.
        iii. MasterEmaco P 124 by Master Builders
        iv. Or equivalent
4. Repair of random cracks (dry – free of liquid or moisture):
    a. 2-component, 100% solids, moisture-tolerant, low-viscosity, high-strength, multipurpose, epoxy resin adhesive.
    b. Acceptable products:
        i. Sikadur 35 Hi-Mod LV by Sika Corporation
        ii. Eucopoxy Injection Resin by Euclid Chemical Co.
        iii. MasterInject 1500 by Master Builders
        iv. Or equivalent
5. Repair of random cracks (wet - presence of liquid or moisture):
    a. Low viscosity polyurethane resin that expands and forms a closed cell foam when it comes in contact with water.
    b. All cracks that are wet (either damp or leaking) at the time of repair shall be repaired with a material that is specifically intended for wet repair as recommended by the manufacturer.
    c. Acceptable products:
        i. SikaFix HH Hydrophilic by Sika Corporation
        ii. Dural Aqua-Fil by Euclid Chemical Co.
        iii. MasterInject 1210 IUG by Master Builders
6. Repair of minor spalls, honeycombs areas and air voids and cementitious overlays:
    a. Polymer modified, non-sag cementitious repair mortar with corrosion inhibitor.
    b. Repair material shall include peastone for repairs of greater depth as required by the manufacturer. For repair areas involving depths generally in excess of three (3) inches, utilize a repair material suitable for the depth of repair.
    c. Acceptable products:
        i. SikaTop 122 Plus or 123 Plus by Sika Corporation
        ii. Tamms Structural Mortar by Euclid Chemical Co.
        iii. MasterEmaco N 400 MasterEmaco N 400
        iv. Or equivalent

PART 3 - EXECUTION

3.1 FORMWORK

A. Forms for manufacturing precast concrete products shall be of the type and design

consistent with industry standards and practices.

B. Forms shall be capable of consistently providing uniform products and dimensions.

C. Forms shall be constructed so that the forces and vibrations to which the forms will be subjected can cause no product damage

3.2 FABRICATION AND PLACING REINFORCEMENT

A. Detailing and fabrication of reinforcement shall conform to the CRSI Code of Standard Practice unless otherwise indicated on the Drawings.

B. Reinforcing steel bars shall be clean and free from loose mill scale and rust and from coatings that reduce bond.

C. Place reinforcement of structural members on accessory bolsters and chairs. Accessories shall be stainless steel or have plastic tips.

D. All reinforcing shall have concrete cover specified.

E. Do not weld reinforcement unless the Engineer takes no exceptions in writing. When permitted, welding shall be in accordance with AWS D1.4/D1.4M.

3.3 PRODUCTION, CURING, FINISHING, REPAIRS AND STORAGE

A. Production, curing and storage of the precast units shall conform to the provisions of MNL 116.

B. Production:

1. Each precast concrete unit shall be an integral placement without any construction or cold joints. Base slabs shall be an integral placement with the bottom wall section.
2. Structures shall be fabricated from the minimum number of precast sections in order to minimize the number of joints. Joints shall be located such that penetrations do not intersect joints.
3. Tolerances: Fabricate precast units without exceeding the tolerances specified below:
    a. Circular structures meeting ASTM C478:
        i. Interior diameter: +/- 1.0%
        ii. Thickness of wall and slabs: -3/16”, +1”
        iii. Offsets in Alignment of Adjacent Members at Any Joint: +/- ¼”
        iv. The inside joint seam gap between two stacked sections before joint sealant is applied shall not exceed 3/8”

C. Curing:

1. All exposed precast concrete shall be cured by either:
    a. Moist curing (steam, ponding or application of burlap kept continuously wet)
    b. Covering the exposed surface with polyethylene sheets
    c. Covering the exposed concrete with membrane curing compounds
    d. Application of steam. This method may only be used after the initial set of the concrete.
2. Alternate wetting and drying shall not be permitted

D. Finishing:
   1. Unless otherwise indicated all surfaces shall be cast with an "As Cast" finish.
   2. All exposed surfaces shall be free of form defects, joint marks and shall be within the color variation as defined by the submitted samples and/or mock-up sample.
   3. Slight color variations, small surface holes (up to ¼ inch diameter) caused by air bubbles will be accepted but no major imperfections, excessive honeycombing, sand streaks or other major defects shall be permitted.

E. Repairs of Defects at the Plant:
   1. Minor defects:
      a. Surface defects not impairing the functional use or expected life of a precast concrete product as determined by the Engineer shall be considered minor defects.
      b. Minor defects shall be repaired by a method that does not impair the product and approved in writing by MICC admixture manufacturer.
      c. All repairs shall be made and identified prior to shipment to the Project site.
   2. Major defects:
      a. Structural defects in precast concrete products that impair the functional use or the expected life of products as determined by the Engineer shall be considered major defects.
      b. All precast units with major defects shall be rejected and not delivered to the Project site

F. Storage:
   1. Areas used for storage of products shall be firm enough and level enough to avoid causing damage to stored products.
   2. Products shall be stored on level surfaces in a manner that will minimize damage caused by uneven bearing, improperly located dunnage blocks, stacking products too high or difficulty in handling.

3.4 HANDLING, AND TRANSPORTATION

A. All precast concrete units shall be lifted using designated pick points and lifting inserts. Extreme caution shall be exercised so as not to damage the units during handling.

B. Prior to shipment:
   1. All precast products shall be inspected by plant personnel to assure design conformance, that all defects have been repaired, that all units have proper identification.
   2. For horizontally installed sections: that all units have proper match marks to facilitate assembly, and units have been dry fit assembled at the plant to ensure proper fit at each joint.
   3. For vertically assembled sections: that all units have proper match marks to facilitate assembly, and units have been dry fit assembled at the plant to ensure proper fit at each joint

4. Products not conforming to requirements shall be clearly labeled and the defects noted on the inspection report. Only products conforming to the requirements shall be shipped.

C. Transportation:
   1. Precast concrete units shall be properly supported during transportation to minimize potential for damage.
   2. Transport units in a position consistent with their shapes in order to avoid excessive stresses that may cause damage. Unique shipping instructions or special stacking may be required for irregularly shaped pieces.
   3. Do not transport units until they have been cured for a minimum of 5 days or have reached 75% of their 28-day design strength.

3.5 REPAIR OF UNITS AT PROJECT SITE

A. Minor defects, as determined by the Engineer, shall be repaired by a method that does not impair the product, and shall be at no additional cost to the Owner. Minor defects:
   1. Form tie holes
   2. Air voids (bugholes)larger than those specified for the required surface finish
   3. Honeycomb areas with a depth less than 1 inch
   4. Blisters
   5. Delaminations
   6. Crusting
   7. Visible construction joints, fins and burs
   8. Non-uniform concrete color and appearance
   9. Floors that are not level

B. Major defects, as determined by the Engineer, shall not be repaired. Precast units with major defects shall be rejected and removed from the Project site and replaced at no additional cost to the Owner. Major defects:
   1. Random cracks
   2. Excessive cracking (crazing)
   3. Spalls
   4. Air voids (bugholes) and honeycombed areas with a depth greater than or equal to 1 inch

3.6 REPAIR OF SURFACE DEFECTS

A. Form Tie Holes: After cleaned and thoroughly dampened, apply grout paint and fill holes solid with patching mortar.

B. Air voids (bugholes): After cleaned and thoroughly dampened, apply grout paint and fill holes solid with patching mortar.

C. Honeycomb areas:
   1. All honeycombed areas shall be removed to sound concrete by means of hand chisels or pneumatic chipping hammers or hydrodemolition.
   2. Saw cut a 1-inch minimum square groove around the edges of the defective area perpendicular to the surfaces to serve as the boundary for concrete removal. Saw cut the edges perpendicular to the surface. No feather edges shall be allowed.

3. Remove all loose aggregate paste and debris and scrub clean. Thoroughly wet area to be repaired. Brush and scrub grout paint into the substrate of the area to be repaired.
4. Mix patching mortar using as little water as possible. Allow to stand with frequent manipulation of trowel to achieve stiffest consistency. Blend white and gray portland cement to achieve color match with surrounding concrete.
5. Prior to the set of grout paint (but after it has cast its water sheen), apply a stiff consistency of patching mortar to the area with a trowel. Leave patched surface slightly higher than surrounding surface. Do not finish for 1 hour minimum. Cure in same manner as adjacent concrete.

D. Blisters, delaminations and crusting: Repairs shall be similar to those for honeycomb areas. Depth of saw cut shall match the depth of the defective concrete.

E. Visible construction joints, fins and burrs: Remove by grinding until a smooth uniform surface is attained.

F. Concrete with an overall non-uniform color or appearance as determined by the Engineer shall be repaired with a complete cementitious overlay. Application of the overlay shall be in strict accordance with the manufacturer's written instructions and recommendations.

3.7 ERECTION OF PRECAST STRUCTURES

A. The General Contractor shall carefully inspect the precast units delivered to the project site prior to commencing installation, and immediately notify the fabricator of any and all deficiencies such as the absence of marked match points on adjacent sections, sections out of specified tolerances, and improperly fabricated sections so that the fabricator can correct such deficiencies, including replacing sections as required.

B. Install all precast structures level, plumb and aligned to the elevations and in the locations shown on the Drawings. All precast concrete units shall be lifted using designated pick points and lifting inserts in accordance with the written instructions from the Precast Concrete supplier.

C. Installation Tolerances: Install precast units without exceeding the tolerances specified in Section 3.3.

D. Attach precast concrete units to concrete foundations as indicated on the Drawings or as required by the Precast Concrete manufacturer.

E. Connect adjacent precast concrete units as required by the manufacturer. All units shall fit tight to their adjacent units.

F. Joints: All joints shall be watertight and shall be sealed as indicated below:
1. Install butyl rubber sealants in all joints. A minimum of 2 rows of sealants shall be applied at each joint.
2. Install butyl joint wraps around the exterior face of all horizontal and vertical joints to achieve watertight joints. For segmental box type tank structures, install wrap on the interior face of joints in the base slab.
3. All sealants and wraps shall be installed in accordance with the manufacturer's recommendations.
4. Install primer as required by the wrap manufacturer. Primer and wrap shall be installed within the temperature range recommended by the manufacturer.

5. Wraps shall be installed directly over the joints prior to installation of any other straps or anchors.
6. Apply concrete repair material to all offsets of 1/8" to 1/4" between adjacent precast sections to provide a smooth transition from one precast section to the next prior to applying the joint wrap.
7. Joints shall be clear of dirt, snow, ice and other debris prior to installing wrap.

G. After erection is complete, all surface damages to the precast concrete units shall be properly repaired in accordance with this Section. All lifting inserts and holes shall be patched after final installation.

3.8 LIQUID ASPHALT DAMPPROOFING APPLICATION

A. Apply dampproofing to the exterior surfaces all below grade precast concrete walls and on the top surface of below grade top slabs.
B. Apply two coats in strict accordance with manufacturer's printed instructions and as specified herein. Clean and prepare surfaces as required.
C. Do not apply dampproofing at temperatures below 40° F or when temperature is expected to fall below 40° F within 12 hours.
D. Do not place backfill for at least 48 hours after application.
E. All damproofing materials spilled on adjacent structures shall be cleaned with a material recommended by the dampproofing manufacturer.

3.9 TESTING

A. General:
   1. Perform leakage tests on all precast concrete structures indicated below prior to application of dampproofing and installing backfill around the structures . Installing backfill at the ends of box type tank structures prior to the leak test will not be permitted.
   2. All testing must be performed in the presence of the Engineer.
   3. Suitably plug all pipes entering precast concrete structures and brace plugs to prevent blow out.
B. Leakage Tests:
   1. Fill precast concrete structures with potable water to within one foot below the underside of the top slab. Contractor shall be responsible for providing potable water for the tests.
   2. A period of up to 12 hours may be permitted, if the Contractor so wishes, to allow for absorption.
   3. At the end of the absorption period, refill precast concrete structures with water to to within one foot below the underside of the top slab and begin the 4-hour test period.
   4. At the end of the 4-hour test period, refill precast concrete structures to the top of the precast concrete structures cover and measure the volume of water added. The test shall be considered passing if the following conditions are met:
      a. The drop in the liquid level does not exceed 1/8 inch
      b. There are no visible leaks on exterior surfaces of the structures or through joints.

5. Contractor shall repair all leaks at no additional cost to the Owner. All repair materials shall be reviewed for information only by the Engineer.
6. Precast concrete structures shall be retested subsequent to repairs.
7. Additional tests and repairs will be performed until such time as the structures can demonstrate compliance with the testing requirements.
8. Contractor shall dispose of water in accordance with all applicable local, State and Federal Regulations.

C. Test Schedule:
   1. The following structures shall be leak tested:
      a. Valve Vault
      b. Wet Well

END OF SECTION

SECTION 03604

NON-SHRINK GROUT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Cementitious non-shrink grout
B. Epoxy non-shrink grout

1.2 RELATED SECTIONS

A. Section 01340 - Submittals
B. Section 03010 – Concrete Modifications and Repairs
C. Section 03300 - Cast-in-Place Concrete
D. Section 03346 - Concrete Finishing and Curing
E. Section 03415 - Structural Precast Prestressed Concrete Plank
F. Section 05500 - Metal Fabrications

1.3 REFERENCES

A. This section contains references that are applicable to this Specification Section. The applicable edition of the indicated references shall be the version that was the most current at the time of the Advertisement of Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued, or replaced.
B. ASTM C33/C33M - Specification for Concrete Aggregates
C. ASTM C109/C109M - Test Method for Compressive Strength of Hydraulic Cement Mortars
D. ASTM C827 - Test Method for Changes in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures
E. ASTM C1107/C1107M - Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
F. CRD-C611 - Test Method for Flow of Grout Mixtures
G. CRD-C621 - Specification for Non-Shrink Grout

1.4 SUBMITTALS

A. Submit product data and material safety data sheets for products to be used.
B. Submit test data when required.
C. Submit manufacturers installation instructions for products used.
D. Submit a list of at least five (5) similar installations of the product during the last 5 years.

1.5 QUALITY ASSURANCE

A. The grout manufacturer shall be ISO 9001 certified and have been in business of manufacturing similar products for over ten (10) years. The manufacturer shall maintain a strict quality assurance program, offer technical services and provide a representative at the jobsite for product training, prior to product installation, upon written request.
B. Conform to Army Corps of Engineers Specification CRD-C621 and ASTM C1107/C1107M (Grades B or C).
C. Grouts shall exhibit non-shrink characteristics when tested according to ASTM C827.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver in original sealed packages or containers, labeled with the manufacturer's identification, printed instructions and batch code.
B. Store in dry conditions above freezing and below 90°F.
C. Keep unused portions of opened containers dry and warm.
D. Store aggregate covered and protected from the elements.

1.7 ENVIRONMENTAL CONDITIONS

A. Do not place grout when exposed to precipitation.
B. Place grout when temperature of substrate and ambient air are above 40°F and below 90°F.
C. Place grout outside these limits when approved by heating substrates, enclosing work, shading, cooling or other measure to mitigate adverse weather conditions.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cementitious grout: consists of premeasured, prepacked flowable cement based grouting material with aggregate requiring only the addition of water.
B. Epoxy grout: consists of premeasured, prepacked epoxy based grouting material consisting of an epoxy resin, hardener and specially blended aggregates. The ratio of the weight of aggregate to the weights of the combined resin and hardener (fill ratio) shall be maintained.
C. Aggregates: ASTM C33/C33M fine aggregate, washed.
D. Pea Stone: ASTM C33/C33M coarse aggregate, size number 8 (max. size 0.375 inches), washed.
E. Water: Potable, from municipal water supply.
F. Epoxy resins shall not contain non-reactive diluents. Resins containing butyl glycidyl ether (BGE) or other volatile and hazardous diluents are not permitted.
G. Utilize proper grout for the intended application as recommended by the manufacturer.

2.2 TESTS

A. All grouts shall achieve a minimum 28 day strength of 6,000 psi according to ASTM C109/C109M.
B. Grouts when tested by flow cone according to CRD-C 611 shall take more than 20

seconds to flow as a maximum limit on fluidity.

C. Test grout when requested.

2.3 ACCEPTABLE PRODUCTS

A. Cementitious Grout
   1. Five Star Grout - Five Star Products, Inc
   2. Masterflow 928 - BASF / Master Builders
   3. NS Grout - Euclid Chemical Company
   4. Crystex - L&M Construction Chemical, Inc.
   5. Harris Construction Grout – A.H. Harris & Sons, Inc.
   6. Or equal

B. Epoxy Grout
   1. HP Epoxy Grout - Five Star Products, Inc.
   2. Masterflow 648 CP Plus - BASF / Master Builders
   3. E3-HP - Euclid Chemical Company
   4. Epogrout 758 - L&M Construction Chemicals, Inc.
   5. Or equal

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

A. Unless otherwise indicated, Follow manufacturer's written instructions.

B. Concrete surfaces shall be a minimum 28 days old.

C. Completely remove all loose concrete, aggregate, dust, laitance, dirt, oil, grease and other contaminants by bush-hammering, chipping, brushing, concrete cleaners or degreasers.

D. Use acceptable mechanical means to obtain clean, sound and rough concrete surfaces, exposing coarse aggregate. Blow surfaces clean of dust and debris using oil-free compressed air.

E. Surface moisture:
   1. Cementitious grout: Soak concrete surfaces thoroughly for a minimum of 8 hours with potable water. Concrete shall be saturated and free of standing water at time of grout placement.
   2. Epoxy grout: Do not pre-soak concrete surfaces prior to grout placement. Surfaces shall be visibly dry.

F. Follow manufacturer’s cold and hot weather grouting procedures to maintain all materials and surfaces that contact grout within acceptable temperature ranges. Heat the substrate and surrounding environment to a minimum of 40° F.

3.2 FORMS

A. Formwork shall be constructed of rigid nonabsorbent materials, securely anchored, watertight and strong enough to resist forces developed during grout placement.

B. Formwork shall be constructed so that the grout is placed across the shortest distance whenever possible. The clearance between formwork and baseplate shall be sufficient to allow for headbox. The clearance for remaining sides shall be one to three inches.

C. Height of formwork shall extend a minimum of one inch above the highest point to be grouted.

D. All formwork shall be coated with a form release agent or plastic sheeting for easy removal. Care should be taken not to contaminate grouting surfaces where bond is required.

3.3 MIXING

A. Provide an adequate number of mortar mixers in good operating condition for uninterrupted placement. Do not exceed one-half the maximum capacity of the mortar mixer.

B. Cementitious grout:
   1. Pre-wet mortar mixer directly prior to mixing. Empty excess water.
   2. Start by adding the minimum amount of premeasured potable water to mixer. While mixing, slowly add grout and mix to a uniform consistency.
   3. Mix thoroughly for approximately four to five minutes. To achieve desired consistency, add remaining water as necessary. Do not exceed maximum water content as stated on product packaging or add an amount that will cause segregation.
   4. For pours requiring aggregate extension, add clean, damp coarse aggregate before final water adjustment.
   5. Do not mix more material than can be placed within the working time of the grout. Do not retemper the mix by adding additional water.

C. Epoxy grout:
   1. Combine resin and hardener into pail containing resin. Mix thoroughly by hand with a paddle or by slow speed mixer until a uniform color (no streaks) is obtained. Avoid air entrapment while mixing. Immediately pour all mixed liquids into mortar mixer. While mixing at a slow speed, slowly add aggregate and mix only until aggregate is completely wet.
   2. Do not mix more material than can be placed within the working time of the grout.

3.4 PLACING

A. Pouring (Cementitious and Epoxy Grout):
   1. A headbox or similar device is required for a continuous pour to avoid air pockets under baseplate. All grouting shall take place from one side to the other, maintaining contact with the bottom of the plate at all times.
   2. When pouring through grout holes, placement shall proceed continuously with a headbox until the grout has risen in the next hole. Maintain head pressure at initial hole so that grout stays in contact with the bottom of the baseplate at all times.
   3. Commence grouting at the next hole with an additional headbox. Continue process, alternating headboxes until grouting is complete.
   4. When pouring into the headbox, grout shall be introduced in a manner to avoid air entrapment. Care must be taken during grouting to keep the headbox at least half full of material to ensure even grout flow. If necessary to assist the flow, a

plunger may be used. This procedure shall continue until the grout rises above the bottom edge of the baseplate on the opposite side.

5. Throughout the pour, forms shall be constantly checked for leaks. All leaks shall be sealed immediately.

B. Pumping (Cementitious Grout):

1. The type and size of pump and discharge line used are dependent on the parameters of each installation. Contact the pump and grout manufacturers for recommendations.
2. Pumping raises the grout temperature and shortens the working time while reducing its consistency. Keep mix temperature as cool as necessary, except in cold weather.
3. The grout shall be mixed to a consistency that will not segregate while pumping.
4. The grout shall be passed through a #4 screen prior to placement into the pump hopper.
5. Before pumping, determine the working time under jobsite conditions. Pumpability shall be determined by field testing.
6. The pump shall be positioned to minimize the pumping distance. Keep the discharge line as close to horizontal as possible. All hose connections must be watertight.
7. Immediately prior to pumping, the pump and lines shall be primed with a priming slurry leaving hopper empty to prevent overwatering.
8. Once the pumping has begun, it is important not to use any of the priming slurry from the discharge lines. Grout shall not be used until a uniform consistency is obtained at the discharge nozzle.
9. Provide an adequate volume of mixed grout to keep the pump hopper at least half full. The grout shall be placed into pump hopper in a manner to prevent air entrapment.
10. The discharge nozzle shall be withdrawn only while pumping, keeping it submerged within the grout at all times.
11. When a pump is needed to transport grout and the nozzle cannot be inserted into the cavity being grouted, a headbox is required. The headbox will allow the pour to be continuous, avoiding air pockets under the plate. The grout shall be discharged from the nozzle into the headbox in a manner to avoid air entrapment. The headbox shall be kept at least half full at all times.
12. All grouting shall take place from one side of the plate to the other. Maintain contact with the bottom of the plate at all times to maximize the effective bearing area (EBA).
13. When pouring through grout holes, placement shall proceed continuously until the grout has risen in the next hole. Maintain head pressure at initial hole so that grout stays in contact with the bottom of the baseplate at all times. Commence grouting at the next hole with an additional headbox. Continue process, alternating head boxes until grouting is complete.

C. Dry pack (Cementitious Grout):

1. A dry-pack consistency is achieved when the mixed grout can be squeezed into a ball by hand without crumbling. Only enough water should come to the surface to moisten the hands.

2. Use a ram with a square cut end and hammer to evenly compact the grout against solidly braced backing boards, combining each layer (approximately 1/2 inch thick) to the previously placed layer over its entire surface.
3. Each placed layer shall be visually inspected for placement uniformity.
4. Striking force should be sufficient for compaction of the grout without affecting plate alignment.
5. Placement shall be continuous until grouting is complete.

3.5 FINISHING AND CURING

A. Finishing:
   1. Cut grout back from bottom of baseplate to the foundation at approximately a 45° angle. Formwork can be removed for cutback when grout offers stiff resistance, or when cut with a steel trowel, stands up without support. Epoxy grout may be finished flush with the edge of the base plate.
   2. Provide smooth finish to exposed grout surfaces.
   3. Grout shall not be allowed to remain above the bottom edge of the baseplate.

B. Curing:
   1. Cementitious grout shall be moist cured for a minimum of three days. Epoxy grout does not require curing agents.
   2. Cementitious Grout shall be protected from excessive evaporation with wet rags prior to set.
   3. Grout shall be protected from wind, rain, freezing and vibration until a minimum compressive strength of 1000 psi is achieved.
   4. Maintain temperature above 45° F until a minimum compressive strength of 1000 psi is achieved.

END OF SECTION

SECTION 08305

SPECIAL DOORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Access Hatches
B. Safety Grating
C. Hatch Rail System

1.2 RELATED SECTIONS

A. Section 01340 - Shop Drawings
B. Section 01710 - Project Cleaning
C. Section 03300 - Cast-in-Place Concrete
D. Section 03420 - Precast Concrete Structures
E. Section 09900 - Painting

1.3 REFERENCES

A. ASTM B 117 - Standard Test Method of Salt Spray (Fog) Testing.
B. ASTM D 714 - Standard Test Method for Evaluating Degree of Blistering of Paints.
C. ASTM D 1654 - Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
D. ASTM D 2794 - Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
E. ASTM D 4541 - Method for Pull-Offs Strength of Coatings Using Portable Adhesion - Testers.
F. ASTM E 74 - Practice for Calibration of Force Measuring Instruments for Verifying the Load Indication of Testing Machines.
G. ASTM E 96 - Test Methods for Water Vapor Transmission of Materials.
H. ASTM E 119 - Fire Tests of Building Construction and Materials.
I. ASTM G 53 - Practice for Operating Light and Water Exposure Apparatus (Fluorescent UV - Condensation Type) for Exposure of Nonmetallic Materials.

1.4 SUBMITTALS

A. Submit product data under provision of Section 01340.
B. Submit large scale details of all items furnished hereunder, and details of installation to the surrounding conditions.
C. Submit manufactures specification and installation instructions.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver fabricated assemblies as job progress requires in the largest sections permitted, properly labeled for field erection.
B. Store in original packaging on site under protective coverings and out of the way of normal construction activities. Provide special storage in accordance with the manufacturer's instructions and recommendations.
C. Handle fabricated assemblies to prevent damage of any nature.

1.6 WARRANTIES

A. Access Hatches: Manufacturer shall guarantee against defects in material or workmanship for a period of five years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Access Hatches
   1. The Bilco Company
   2. Babcock-Davis Hatchways, Inc.
   3. Or equal.
B. Water-tight
   1. Presray
   2. Or equal
C. Safety Grating
   1. Safety grating shall be by Hatch Manufacturer.

2.2 FLOOR ACCESS HATCHES

A. Size shall be as indicated on the Drawings.
B. Aluminum cover and frame: Cover shall open to 90* and lock automatically in the open position. A vinyl grip handle shall be provided to release the cover for closing. Covers shall be constructed for a minimum live load of 300 pounds per square foot and equipped with a snap lock with removable handle and exterior lock system.
C. Door leaf(s) and channel frame to be constructed of ¼-inch aluminum. Door leaf(s) to be equipped with enclosed compression spring operators for easy opening stainless steel hinges and pins. Hardware shall be stainless steel.
D. The cover frame shall be integrally cast in the top concrete slab. Mill finish with bituminous coating to the exterior of the frame.
E. Hatch covers with grating shall be the manufacturer's standard aluminum grating framed with aluminum supports and plating.

2.3 SAFETY GRATING

A. Provide Hatch Safety grating, by Hatch Manufacturer at all new hatchesSystem shall be a hinged, lockable aluminum grating panel installed beneath the access hatch meeting the requirements listed herein.
   1. Aluminum "I" bar construction
   2. T-316 stainless steel hardware
   3. Hinged with automatic hold open arm to maintain upright position.
   4. Load rating of 300 pounds per square foot.
C. Grating to have safety orange powder-coated finish.
D. Safety grating shall meet OSHA standard 1926.502 for fall protection.
E. Grate shall be lockable with maximum grate openings not exceeding 5 inch by 5 inch, and maximum side clearance of 4 inches.
F. Provide automatic hold open arm.
G. Install per manufacturers recommendation.
H. System shall have a 3-year guarantee by the manufacturer.

2.4 FINISHES

A. Mill finish aluminum, polyamide epoxy primer at steel hatches.
B. Polyamide epoxy (5 mils) or manufacturer's standard bituminous coating applied to exterior of the frame in contact with concrete.
C. All coatings shall comply with Local, State and Federal regulations.

PART 3 - EXECUTION

3.1 ACCESS HATCH INSTALLATION

A. Installation shall be in accordance with manufacturer's instructions.
B. Coordinate the hatch installation with the drain piping.
C. Install the ladder safety post in the middle of the top two rungs of the ladder.
D. Cover and protect the installed hatches from splatter or debris and from damage or staining by adjacent work until accepted by the owner.

END OF SECTION

SECTION 09900

PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes surface preparation and field painting of the following surfaces of new items unless specified elsewhere to be prefinished. This includes pre-primed surfaces.
   1. Painting of all submerged surfaces.
   2. Painting of all exposed interior surfaces.
   3. Painting of all exposed exterior surfaces.
   4. Staining of exterior and interior exposed wood surfaces.
   5. Staining of concrete surfaces.

B. Painting of existing items:
   1. Existing floors, walls and ceilings to receive surface preparation and field painting are indicated on the drawings and in the specifications.
      a. All previously painted items located within floors, walls and ceilings indicated to be painted will also receive surface preparation and field painting.
   2. Any other existing items on the drawings or in this specification indicated to be painted will receive surface preparation and field painting.

C. This Section also includes:
   1. Piping runs above finished ceilings shall be considered exposed and shall be painted.
   2. Back prime, with specified interior first coat, all surfaces of wood finish and trim which will be concealed after installation.
   3. All surfaces of ferrous metal fabrications built into concrete and masonry shall be shop primed or receive a primer coat in accordance with this section. All surfaces exposed to view shall receive intermediate and finish coats.
   4. Pipe, pump and valve identification markers.
   5. Skid resistant floor coating where shown on the Drawings.
   6. Secondary containment coatings.
   7. Motors and equipment which are pre-finished shall receive one top coat to provide a color matching the system color indicated in the pipe identification schedule.
   8. Load rating identification markings for monorails and lifting hooks.
   9. Paint all items modified or relocated in the existing facility.

D. Definitions:
   1. Submerged surfaces are defined as:
      a. Those surfaces which are below the maximum water surface level as indicated on the drawings, and/or extend 3-feet above the maximum water surface for uncovered tanks.
      b. All surfaces contained within covered tanks.

c. The full height of all partially submerged items such as sluice, slide and weir gates, piping, etc.
d. All surfaces contained within underground vaults, structures and manholes such as valve pits, dry wells, etc.

2. Exposed interior surfaces shall be non-submerged surfaces exposed to view that are enclosed and/or protected in such a manner that they cannot be exposed to UV light or weather conditions.
3. Exposed exterior items shall be all other surfaces which don't fall under the definition of "submerged" or "exposed interior surfaces".

E. Items not requiring surface preparation and field painting:
1. Items and equipment that are specifically specified to receive the manufacturer's standard primer and finish coats in the factory, except as noted for color and touch-up painting.
2. Copper, bronze, brass, chromium plate, nickel, stainless steel, aluminum or monel metals (unless otherwise noted).
3. Unprimed galvanized metals not indicated to be painted shall remain unfinished.
4. Face brick, decorative CMU, architectural precast concrete and tile.
5. Concrete slabs and walls unless indicated in the finish schedule on the drawings to be painted or receive secondary containment coatings.
6. Underside of exposed metal decks unless indicated to be painted in the finish schedule.
7. Prefinished fiber cement siding as specified in Division 7.
8. Acoustic tile ceilings specified in Division 9.
9. Acoustical sound control panels or sprayed on acoustical insulation specified in Division 9.
10. Aluminum door, windows and framing specified in Division 8.
11. Vinyl windows specified in Division 8.
12. Toilet partitions and screens, metal lockers and toilet bath accessories specified in Division 10.
13. Laboratory, kitchen and office casework specified in Division 12.

1.2 REFERENCES

A. ASTM D2247 - Practice for Testing Water Resistance of Coatings in 100 Percent Relative Humidity.
B. ASTM D 2794 - Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
C. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
D. DASTM D6386 - Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Products for Painting
E. Federal Test Method No. 141 - Method 6141, Stain Removal.
F. ANSI A13.1 - Scheme for the Identification of Piping Systems.
G. SSPC - Steel Structures Painting Council.
H. SSPC-PA1, "Standard for Shop, Field, and Maintenance Painting."
I. SSPC-PA2, "Measurement of Dry Paint Thickness with Magnetic Gauges."
J. SSPC-SP1, "Solvent Cleaning."

K. SSPC-SP2, “Hand Tool Cleaning.”
L. SSPC-SP3, “Power Tool Cleaning.”
M. SSPC-SP6, “Commercial Blast Cleaning.”
N. SSPC-SP7, "Brush Off Blast."
O. SSPC-SP10, “Near-White Blast Cleaning.”
P. SSPC-SP16, "Brush Blast Cleaning of Non Ferrous Metals"
Q. SSPC-PA Guide 3, Standard “A Guide to Safety in Paint Application,” latest revision.
R. VOC Standards - All coatings shall be in accordance with all applicable State and Federal VOC Standards.
    1. OSHA 29 CFR 1925.55 Gases, Vapors, Fumes, Dusts and Mists.
    2. Ozone Transportation Commission (OTC) 2005 VOC Regulation.

1.3 SUBMITTALS

A. Submit product data under provisions of Section 01340 including tested performance characteristics.
B. Submit manufacturer’s color chips showing the full range of colors available for each type of finish coat material specified.
C. Submit schedule on manufactures letter head with list of items to be coated, type and manufacturer of shop coating and type of field coating, including primers, details on surface preparation methods, application procedures and dry mil thickness.
D. Submit a letter from the manufacturer certifying that the products submitted are applicable for the applications indicated.
E. Submit coating manufacturer’s certification that the proposed coatings meet all state and federal VOC regulations.

1.5 QUALITY ASSURANCE

A. The Contractor shall obtain the services of a painting contractor with 5 years experience on similar projects.
B. All materials used on work shall be exactly as specified in brand and quality. No claim by the Contractor as to unsuitability or unavailability of any material specified, or their unwillingness to use same, or their inability to produce first class work with same, will be entertained unless such claims are made in writing and submitted to the Engineer at least seven (7) days prior to the date established for receipt of General Bids.
C. Before purchasing materials for the work, the Contractor shall submit to the Engineer a list of the products they propose to use, and the list shall be reviewed by the Engineer with a status of no exceptions taken before commitment for materials is made.
D. Materials selected for coating systems for each type of surface shall be the products of a single manufacturer.
E. Include on label of all containers:
    1. Manufacturer's name
    2. Type of paint
    3. Manufacturer's stock number
    4. Color
    5. Instructions for reducing, where applicable

6. Label analysis
7. Shelf life dates

F. Field Quality Control:
   1. Contractor shall request review by the Engineer, of first finished room, space or item of each color, texture and method of applications, prior to proceeding with additional painting.
   2. Use first acceptable room, space or item as the project standard for each color scheme.
   3. For spray application, when applicable, paint a surface not smaller than 100 square feet as the project standard.
   4. Repainting of materials failing to meet the requirements of the Specifications or Drawings, shall be performed by the Contractor, at no additional cost to the Owner.
   5. The number of coats and total mil thickness specified in the paint schedule are minimums. If the specified minimum film thickness is not achieved, additional coats shall be applied to achieve the total film thickness specified.

G. All coating systems used for potable water applications shall be previously approved by the National Sanitation Foundation (NSF) in accordance with Standard 61. Evidence of compliance shall be an approval letter from NSF listing the submitted material.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver coating materials in sealed containers with labels legible and intact.
B. Store only acceptable project materials on the project site.
C. All painting materials shall be stored and mixed in a single location coordinated with the Engineer. The Contractor shall not use any plumbing fixture or pipe for mixing or for disposal of any refuse. The Contractor shall carry all necessary water to the mixing room and shall dispose of all waste outside of the building in a suitable receptacle.
D. Restrict storage location to paint materials and related equipment and supplies.
E. Keep storage location neat and clean.
F. Remove all soiled and used rags, waste and trash from the storage location and building at the end of each workday.
G. Repair all damage to the storage location, caused by painting materials and equipment at no additional cost to the Owner.
H. Comply with all applicable health and fire codes and regulations including safety precautions recommended by the manufacturer. Storage space shall be provided with a suitable fire extinguisher fully charged at all times.
I. Heat shall be provided in the storage area if paints are to be stored during winter months. The temperature shall be maintained above 40 degrees F at all times.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Comply with manufacturer's recommendations as to environmental conditions under which coatings and coating systems shall be applied.
B. Do not apply coatings in areas where dust is being generated.
C. Do not apply coatings when the air or material surface temperature is below 50

degrees Fahrenheit and unless the temperature is at least 5 degrees Fahrenheit above the dew point.

D. Do not apply exterior coatings in frosty, damp or rainy weather or while surfaces are exposed to hot sunlight.

1.8 EXTRA MATERIALS

A. For all materials with a shelf life of greater than 12 months, provide one gallon of each type and each color of touch-up paint shall be provided to the Owner by the Contractor in unopened containers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Tnemec Company, Inc.
B. Sherwin Williams
C. PPG
D. Or equal

2.2 MATERIALS

A. Refer to the paint schedule in Part 3 for specific products and application.

2.3 COMPONENTS

A. All finish coats shall be compatible with shop prime coats.
B. Turpentine shall be pure spirits of turpentine.
C. Shellac shall be four pounds and shall meet the U.S. Government specifications as issued by the Bureau of Commerce.
D. When metal is primed in the mill or shop as part of painting contract, use the materials specified in every case for such surfaces and use in accordance with manufacturer's directions for first or priming coat.

2.4 MIXING AND TINTING

A. Deliver paints and enamels ready-mixed to project site.
B. Accomplish job mixing and job tinting only when required.
C. Mix only in mixing pails placed in suitably sized nonferrous or oxide resistant metal pans.
D. Use only tinting colors recommended by the manufacturer for the specific type of finish.
E. Fungicidal agents, when applicable, shall be incorporated into the paints and stains by the manufacturer.
F. Mix and prepare paints in strict accordance with Manufacturers recommendations.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine surfaces scheduled to receive paint and finishes for conditions that will adversely affect execution, permanence or quality of work and which cannot be put into an acceptable condition through preparatory work as included in Part 3.2, Surface Preparation.

B. Immediately notify the Engineer in writing when a surface to be finished cannot be put into an acceptable condition.

C. Do not proceed with surface preparation or coating application until conditions are suitable.

D. The Contractor shall be responsible for and shall rectify, at no additional cost to the Owner any unsatisfactory finish resulting from the application of coatings on surfaces not in acceptable condition.

3.2 SURFACE PREPARATION

A. At a minimum, all surfaces must be prepared and cleaned in accordance with the manufactures written specifications and pertaining to the intended substrate to be coated. The contractor must be fully read and understand all of these requirements and all other required product recommendations prior to commencing any work.

B. Wood and Plywood to be Painted or Finished Natural:

1. Clean soiled surfaces.
2. Except when rough surface is specified, sand to smooth and even surface, then dust off.
3. Apply shellac to all knots, pitch and resinous sapwood after washing with mineral spirits and, before priming coat is applied.
4. Fill nail holes, cracks, open joints and other defects with paste wood filler before priming coat surface and color to match finish color. When wood filler is applied on open grain wood, allow the grain to secure a smooth, clean surface.
5. Tint filler to match finished wood to be stained.

C. Concrete and Masonry:

1. Clean all dust, dirt, oil and efflorescence from surfaces.
2. Repair cracks and concrete defects in accordance with Specification Section 03346 prior to installing coating system. Finished concrete surface to have a smooth, uniform texture.
3. Etch dense and smooth concrete, or concrete that has had a hardener applied, with a five percent solution (by weight) of muriatic acid.
4. Ensure concrete masonry units have a smooth, uniform texture and are free of voids and bug holes in the surface prior to installing coating systems.
5. Fill concrete masonry unit surfaces with block filler in sufficient thickness to produce a final result which shall fill all voids and pin holes.
6. Allow surfaces to thoroughly dry prior to application of first coat.

D. Ferrous Metal Surfaces (Items not shop primed):

1. All submerged ferrous metals shall be sandblast cleaned in accordance to SSPC-SP10 immediately prior to priming.

2. All other ferrous metals shall be sandblast cleaned in accordance to SSPC-SP6 immediately prior to priming.
3. Remove dirt, oil and grease by washing surfaces with mineral spirits.
4. Surfaces shall be dry and free of dust, oil, grease and other foreign material before priming.
5. Feather edges of sound existing paint by grinding, if necessary.
6. Clean and touch up weathered, worn or damaged shop coats of paint with the specified primer.
7. Restore shop coats of paint with identical materials if removed for welding and fabrication.

E. Galvanized metals indicated to be painted:
1. Solvent clean in accordance with ASTM D6386.
2. Surfaces shall receive SSPC-SP-16 and shall be surfaced prepared in accordance with ASTM D6386.
3. Surfaces shall be dry and free of dust, oil, grease and other foreign material before priming.
4. Restore shop coats of paint with identical materials if removed for welding and fabrication.

F. Previously Coated Surfaces (including existing items and new items that are shop primed):
1. The areas of the coated surface that are blistered, eroded, brittle or otherwise failed shall be completely removed before beginning the specified surface preparation.
2. The areas where the existing coating is intact shall be sanded to dull the finish.
3. Before applying the new coating over an existing coating, a test section must be done to ensure compatibility of the new and old coatings.
4. All other existing coatings shall be prepared as recommended by the manufacturer and as specified in this section.
5. Ferrous metals arriving at the job site with shop primers other than the polyamide epoxy or rust inhibitive primers specified shall be provided with an intermediate coat as necessary for compatibility with specified topcoats.
6. Special attention shall be paid to the potential for epoxy shop and intermediate coats to chalk upon exposure to sunlight. The Contractor shall follow the manufacturer's required surface protection/covering and surface preparation recommendations before any intermediate or top coats can be applied over chalked surface. Epoxy primers and intermediate coats shall be top coated no later than 45 days after the application of the epoxy coating. If topcoats are to be applied later than 45 days, the following surface preparation shall be provided:
    a. The existing finish shall be etched by sanding with 80 grit paper or cloth.
    b. Surfaces shall be pressure washed with 3000 to 5000 pounds of pressure.
    c. The Engineer, at their discretion, can require the Contractor to conduct adhesion tests of the topcoats.

3.3 APPLICATION

A. Workmanship:
   1. Employ skilled workmen to insure workmanship of the highest quality.
   2. Materials shall be applied only by craftsmen experienced in the use of the specific products involved.

B. General Requirements:
   1. Apply all coatings under adequate illumination.
   2. Perform no work in the rain, dew, or fog, when the temperature is below 50 degrees Fahrenheit and at least 5 degrees Fahrenheit above the dew point, or before the other coats have thoroughly dried.
   3. Do not apply coatings until the material surfaces are thoroughly dry.
   4. Apply paints with suitable brushes, rollers or spraying equipment.
      a. The rate of application shall not exceed that as recommended by the paint manufacturer for the surface involved.
      b. Keep brushes, rollers and spraying equipment clean, dry and free from contaminates and suitable for the finish required.
      c. Make each coat a different tint from that of the preceding coat, with final coat tinted to the exact shade selected by the Engineer. Lightly sand surfaces between each coat of gloss and semi-gloss finishes, and wipe clean.
   5. Comply with the recommendation of the product manufacturer for drying time between succeeding coats. Contractor shall follow the manufacturer's specific curing requirements for rust inhibitive primer shop coats prior to allowing top coating.
   6. Sand and dust between each coat to remove defects visible from a distance of five feet.
   7. Finish coats shall be smooth, free of brush marks, streaks, laps or pile up of paints and skipped or missed areas.
   8. Inspection:
      a. Do not apply additional coats until the completed coat has been inspected by the Engineer.
      b. Only inspected and reviewed coats will be considered in determining the number of coats applied.
   9. Leave all parts of moldings and ornaments clean and true to details with no undue amount of paint in corners and depressions.
   10. Make edges of paint adjoining other materials or colors clean and sharp with no overlapping.
   11. Apply primer on all work before glazing.
   12. Refinish entire wall where portion of finish has been damaged or is not acceptable.
   13. Runs on face are not permitted.

3.4 PROTECTION

A. Furnish and lay drop cloths in all rooms and areas where painting and finishing is being done to adequately protect flooring and other work from damage during the

prosecution of the painting work.

B. Remove all canopies of lighting fixtures, all electric switch plates, and similar equipment, set them carefully away, and cover adequately, protect the fixtures, etc.; replace the canopies, plate, etc. in as good condition as when found.

C. Do not paint over any code-required labels, such as Underwriter's Laboratories and Factory Mutual, or any equipment identification, performance rating, name, or nomenclature plates.

D. Correct and refinish all interior and exterior surfaces in the existing facility affected by the new work. Materials and their application shall be as required to most closely match the existing finishes and as specified in this Section.

3.5 CLEANING

A. At the completion of the work of this Section, remove all paint spots and oil or grease stains, caused by this work from floors, walls, fixtures, hardware and equipment, leaving their finishes in a satisfactory condition. Remove all materials and debris and leave the site of the work in a clean condition so far as this work is concerned.

3.6 FINAL INSPECTION

A. Protect all painted and finished surfaces against damage until the date of final acceptance of the work. The Engineer will conduct a final inspection of all painters' work. As part of the final inspection the Contractor shall demonstrate compliance with the specified film thickness with appropriate paint gauges. The Contractor shall be required to repaint, refinish, or retouch any areas found which do not comply with the requirements of this Section.

3.7 LOAD RATING IDENTIFICATIONS

A. Provide markings indicating the load rating of all hoists, monorails and lifting hooks.

B. Markings shall be 3-inches high stenciled letters painted adjacent to the item in a color contrasting the background color.

3.8 PAINT SCHEDULE, GENERAL

A. The following product model and coatings system numbers are listed below to establish the standard of quality. Equivalent products from other manufactures will be accepted provided they meet or exceed the performance of the listed products.

B. If finish coats are compatible with the shop primer on shop primed items, the primer coats listed below are not required on shop primed items. Installer to verify that proposed field coatings are compatible with shop coatings. If the finish coats are not compatible with shop primer coat, painter to provide a polyamide epoxy intermediate coat for compatibility.

C. Shop primed hollow metal doors and frames shall receive the primer coat listed below, regardless of compatibility.

D. Surface prep shall be as specified within this specification section, as noted below and as required per manufacturer recommendations.

E. When applying coats over epoxy coatings that have been in place for more than 45 days, prepare surface in accordance with the “Surface Preparation” section of this specification.

F. When applying coats over previously painted items in an existing facility, verify the products specified below are compatible with the existing coatings. If specified coatings are not compatible, prepare surface in accordance with the "Surface Preparation" section of this spec and provide a bonding primer that is compatible with the existing and specified coatings.
G. All film thicknesses are listed as dry film thicknesses and are the minimum required.

3.9 PAINTING SCHEDULE, INDUSTRIAL COATINGS

A. General: This section covers painting of the piping and equipment systems including but not limited to, valves, levers, valve handles, fittings, stands, supports, hangers, pumps, motors and appurtenances.
B. Submerged Ferrous Metals in contact with potable water: Two finish coats over a primer.
    1. Surface Preparation: SSPC-SP10 Near White Metal Blast Cleaning
    2. Primer:
        a. Tnemec: 94 H20 Hydro-Zinc at 2.5-3.5 mils
        b. Sherwin-Williams: Corothane I Galvapac Zinc Primer at 3.0 – 4.0 mils
        c. PPG: Amercoat 68HS
    3. Two Finish Coats:
        a. Tnemec: N140F at 6 to 8 mils
        b. Sherwin-Williams: Macropoxy 646 PW Epoxy at 6.0 – 10.0 mils
        c. PPG: Amerlock 2
C. Submerged Ferrous Metals in contact with sewer water with high hydrogen sulfide exposures: Process piping and equipment systems located in the preliminary treatment channels, the headworks structure, wetwells, sludge holding tanks, sludge wetwells, and dewatering, filtrate and centrate tanks, 1 primer coat, 1 intermediate coat and 1 finish coat.
    1. Surface Preparation: SSPC-SP10 Near White Metal Blast Cleaning
    2. Primer:
        a. Tnemec: Series N69 Tneme-Epoxoline 11 at 3 to 5 mils
        b. Sherwin-Williams: SW Sher-Glass FF Epoxy at 8 to 10 mils
        c. PPG: Sigmashield 880 at 12-16 mils
    3. Intermediate Coat:
        a. Tnemec: Series N69 Tneme-Epoxoline 11 at 3 to 5 mils
        b. Sherwin-Williams: N/A
        c. PPG: N/A
    4. Finish Coat:
        a. Tnemec: Series N69 Tneme-Epoxoline 11 at 3 to 5 mils
        b. Sherwin-Williams: SW Sher-Glass FF Epoxy at 8 to 10 mils
        c. PPG: Sigmashield 880 at 12-16 mils
D. All other Submerged Ferrous Metals: Two finish coats over a primer.
    1. Surface Preparation: SSPC-SP10 Near White Metal Blast Cleaning
    2. Primer:
        a. Tnemec: Series N69 Tneme-Epoxoline 11 at 3 to 5 mils
        b. Sherwin-Williams: Macropoxy 646 Epoxy at 5.0 –6.0 mils
        c. PPG: N/A

3. Two Finish Coats:
    a. Tnemec: Series N69 Tneme-Epoxoline 11 at 3 to 5 mils
    b. Sherwin-Williams: Macropoxy 646 PW Epoxy at 5.0 –6.0 mils
    c. PPG: Amercoat 240 at 6-8

E. All portions of submerged metals subjected to UV Exposure: Provide 1 additional finish coat as indicated in this section in addition to the primer coat and 2 finish coats specified for submerged ferrous metals.
1. Finish Coat:
    a. Tnemec: Series 73 Endura-shield at 3 to 4 mils
    b. Sherwin-Williams: Acrolon 218 HS Acrylic Polyurethane at 3 to 4 mils
    c. PPG: Amershield VOC

F. Weather Exposed Ferrous Metal Piping and Equipment: Two finish coats over a primer.
1. Surface Preparation: Per Manufacturer's Specifications
2. Primer:
    a. Tnemec: Series N69 Tneme-Epoxoline 11 at 3 to 5 mils
    b. Sherwin-Williams: Macropoxy 646 Epoxy at 5.0 –6.0 mils
    c. PPG: Amerlock 2/400
3. Two Finish Coats:
    a. Tnemec: Series 73 Endura-shield at 3 to 4 mils
    b. Sherwin-Williams: Acrolon 218 HS Acrylic Polyurethane at 3 to 4 mils
    c. PPG: Amershield VOC

G. Enclosed Ferrous Metal Piping and Equipment: Two finish coats over a primer.
1. Surface Preparation: Per Manufacturer's Specifications
2. Primer:
    a. Tnemec: Series N69 Tneme-Epoxoline 11 at 3 to 5 mils
    b. Sherwin-Williams: Macropoxy 646 Epoxy at 5.0 –6.0 mils
    c. PPG: Amerlock 2/400
3. Two Finish Coats:
    a. Tnemec: Series N69 Tneme-Epoxoline 11 at 3 to 5 mils
    b. Sherwin-Williams: Macropoxy 646 Epoxy at 5.0 –6.0 mils
    c. PPG: Amerlock 2/400

H. Plastic Clad Insulated Pipe: One finish coat over a primer.
1. Surface Preparation: Clean & Dry
2. Primer:
    a. Tnemec: Series N69 Tneme-Epoxoline 11 at 3 to 5 mils
    b. Sherwin-Williams: Extreme Bond Bonding Primer at 2 to 5 mils
    c. PPG: Amerlock 2/400
3. Finish Coat:
    a. Tnemec: Series 1028/1029 Enduratone at 2 to 3 mils
    b. Sherwin-Williams: Pro Industrial Acrylic Coating at 3 to 4 mils
    c. PPG: Durethane topcoat

I. PVC Pipe and PVC Conduit: One finish coat over a primer.
1. Surface Preparation: Clean & Dry - Scuffed Up with Medium Grit Sandpaper
2. Primer:
    a. Tnemec: Series N69 Tneme-Epoxoline 11 at 3 to 5 mils

b. Sherwin-Williams: Extreme Bond Bonding Primer at 2 to 5 mils
c. PPG: Amerlock 2/400

3. Finish Coat:
   a. Tnemec: Series 1028/1029 Enduratone at 2 to 3 mils
   b. Sherwin-Williams: Pro Industrial Acrylic Coating at 3 to 4 mils
   c. PPG: Durethane topcoat

3.10 PIPING IDENTIFICATION SCHEDULE

A. Pipe Coating
   1. All pipes, whether concealed or exposed to view shall be painted a separate color as directed by the Engineer. For insulated pipes, only the insulation shall be painted.
   2. Pipe supports consisting of pipe rings, clamps, clevises, U bolts, pipe rollers, saddles, etc., shall be painted with the same color as that of the pipe.
   3. Wall supported pipe hangers consisting of brackets, standoffs, etc., shall be painted with the same color as that of the wall.
   4. Ceiling/roof supported pipe hangers consisting of thread rods, beam clamps, etc., shall be painted with the same color as that of the ceiling.
   5. Floor supported pipes consisting of stanchions shall be painted with same color as that of the pipe.

B. Pipe Markers
   1. Markers shall be corrosion resistant laminated plastic bound to the pipes with nylon fasteners or shall be "coil-fit." Stickers are not acceptable. Markers and flow direction indicators shall be manufactured by Seton, Brimar Industries, or equivalent.
   2. Pipes with diameters less than 1-1/4 inch shall have marker hung from pipe with nylon fasteners.
   3. Lettering size shall be in accordance with the following:

SIZE OF LEGEND LETTERS

Outside Diameter of Pipe or Covering	Minimum Length of Marker	Size of Letters
In	In	In
Up to 1-1/4	8	1/2
1-1/2 to 2	8	3/4
2-1/2 to 6	12	1-1/4
8 to 10	24	2-1/2
Over 10	32	3-1/2

   4. Adjacent to each marker there shall be an arrow indicating flow direction.
   5. Marker location shall be in accordance with the American National Standard Institute Scheme for Identification of Piping Systems (ANSI A13.1). Markers shall be placed adjacent to all valves and/or flanges; adjacent to all changes in direction on all pipe branches; and where all pipes pass through walls or floors on each side of wall/floor. On straight runs of piping, markers shall be placed at no less than 10 foot intervals. Where pipes are located above or below the

normal line of vision, the lettering shall be placed below or above (as appropriate) the horizontal centerline of the pipe.

C. Valve Status Indication Arrows
   1. Valve status indicator alignment arrows shall be provided on the indicator and scale sides of all interior hand wheel, chain and lever operated valves. Arrow heads shall appear aligned when the valve is in the full-open position. Arrow heads shall be painted on with stencils, or a color contrasting with the color of the valve. Arrow heads shall be minimum of 3/4-inch in smallest dimension. Valve position indicators shall be aligned to be visible from normal working levels.

D. Refer to Specification Sections 11000 and 15100 for Equipment and Valve Identification requirements.

END OF SECTION

SECTION 09905

SHOP COATINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Surface preparation and application of shop coatings on materials, equipment, and piping indicated in the various specification sections relating thereto, and as specified herein, including primers and topcoats for materials, equipment and piping that are finished at the point of manufacturer or fabrication.

B. Examine the various Sections of the Specifications and be thoroughly familiar with all provisions regarding shop coatings.

1.2 PREFINISHED ITEMS NOT REQUIRING PAINT OR FINISH

A. Copper, bronze, brass, chromium plate, nickel, stainless steel, aluminum or monel metals, except surfaces in contact with or embedded within concrete or masonry, unless otherwise specified elsewhere.

1.3 REFERENCES

A. ASTM D2247 - Practice for Testing Water Resistance of Coatings in 100 Percent Relative Humidity.

B. ASTM D 2794 - Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).

C. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.

D. Federal Test Method No. 141 - Method 6141, Stain Removal.

E. SSPC - Steel Structures Painting Council.

F. SSPC-PA1, “Standard for Shop, Field, and Maintenance Painting”.

G. SSPC-PA2, “Measurement of Dry Paint Thickness with Magnetic Gauges”.

H. SSPC-SP1, “Solvent Cleaning”.

I. SSPC-SP6, “Commercial Blast Cleaning”.

J. SSPC-SP10, “Near-White Blast Cleaning”.

K. SSPC-SP16, "Brush Blast Cleaning of Non Ferrous Metals"

L. SSPC-PA Guide 3, Standard “A Guide to Safety in Paint Application”, latest revision.

1.4 SUBMITTALS

A. Submit product data under provisions of Section 01340.

B. As a minimum, the following shall be included in the submittal package for all items, products, material or equipment, as specified.

1. Submit data on the proposed shop coatings, details on surface preparation methods, application procedures and dry mil thickness.
2. Submit a minimum of three (3) color charts for all factory top coats for color selection by Engineer.
3. Submit coating manufacturer’s certification that proposed shop coatings are compatible with field coatings, as specified in Section 09900.

1.5 QUALITY ASSURANCE

A. All Shop Coatings shall meet the requirements of the materials section and shall be

guaranteed by the manufacturer to be compatible with the field coatings, as specified in Section 09900. The Contractor shall coordinate this requirement during the Shop Drawing Phase.

B. All Shop Coatings shall meet all Federal and State regulations pertaining to Volatile Organic Compounds (VOC) compliance.

C. All Shop coatings used for potable water applications shall be certified by the National Sanitation Foundation (NSF) in accordance with Standard 61. Evidence of compliance shall be a letter from NSF listing the submitted material.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Refer to Part 3 - EXECUTION for specific products and applications.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

A. Definitions
   1. Submerged surfaces are defined as:
      a. Those surfaces which are below the maximum water surface level as indicated on the drawings, and/or extend 3’-0” above the maximum water surface for uncovered tanks.
      b. All surfaces contained within covered tanks.
      c. The full height of all partially submerged items such as sluice gates, slide gates, weir gates, piping, etc.
      d. All surfaces contained within underground structures, vaults and manholes such as valve pits, drywells, etc.
   2. Enclosed surfaces are those non-submerged surfaces enclosed and/or protected within a building in such a manner that it can not be exposed to UV light or weather conditions.
   3. Weather exposed surfaces are all other conditions including buried items which do not fall into the definition of submerged or enclosed surfaces, as noted above.

B. Ferrous Metal
   1. All submerged ferrous metals shall be sandblast cleaned in accordance to SSPC-SP10, near white, immediately prior to priming.
   2. All other ferrous metals, Enclosed and Weather exposed surfaces, shall be sandblast cleaned in accordance to SSPC-SP6, commercial grade, immediately prior to priming.
   3. Remove dirt, oil and grease by washing surfaces with mineral spirits.
   4. Surfaces shall be dry and free of dust, oil, grease and other foreign material before priming.

C. Galvanized Metal (nonferrous metals indicated to be painted):
   1. Solvent clean in accordance with ASTM D6386.
   2. Surfaces shall receive SSPC-SP-16 and shall be surfaced prepared in accordance with ASTM D6386.
   3. Surfaces shall be dry and free of dust, oil, grease and other foreign material before priming.
   4. Restore shop coats of paint with identical materials if removed for welding and

fabrication.

3.2 APPLICATION

A. Equipment

1. Motors, speed reducers and similar parts shall have a surface preparation in accordance with the manufacturer standard coating requirements and suitable for weather exposed use. The minimum coating system shall be 3 coats of polyamide epoxy at a minimum of 3 mils per coat. Other coatings must be approved by the Engineer.
2. Items finished at the point of manufacture (shop primed and painted), such as submersible pumps and other similar surfaces, shall receive manufacturer's standard coating of baked, powder epoxy enamel, suitable for the intended service.
3. All equipment casing openings requiring protection shall have a water repellent tape and vapor phase inhibitor treated paper.
4. All other ferrous surfaces shall be factory primed in accordance with Section 3.2.C, except ferrous surfaces obviously not to be painted (such as gears, exposed machined or bearing surfaces, enclosed machined or bearing surfaces, lubricated contact surfaces moving under load, thread connections to be field connected and other similar items) which shall be given a heavy shop coat of grease or other suitable rust resistant coating per manufacturer's recommendations.
5. These coating shall be maintained as necessary to prevent corrosion during all periods of storage and erection, until final acceptance by the Owner.

B. Pipe, Fittings and Valves

1. The following surfaces shall be prepared in accordance with the manufacturer's recommendations and shall receive a shop coat of asphaltum varnish meeting Federal Specifications TT-C-494A or fusion bonded epoxy coating.
   a) Interior surfaces of all hydrants, ductile iron pipe, fittings and valves except for air piping lines and air valves which shall be completely unlined.
   b) The exterior surfaces of buried valves and miscellaneous piping appurtenances.
2. The exterior surfaces of all ductile iron pipe and fittings buried shall receive the standard factory applied asphaltic coating (in accordance with AWWA C151).
3. The exterior surfaces of ductile iron pipe, fittings and valves submerged, enclosed or weather exposed shall receive a factory applied shop primer in accordance with Section 3.2.C
4. Machined surfaces shall be cleaned and coated immediately after being machined, with a suitable rust resistant coating per manufacturer's recommendations.
5. All other ferrous surfaces shall be factory primed in accordance with Section 3.2.C, except ferrous surfaces obviously not to be painted shall receive a heavy shop coat of grease or other suitable rust resistant coating per manufacturer's recommendations.
6. These coating shall be maintained as necessary to prevent corrosion during all periods of storage and erection until final acceptance by the owner.

C. Schedule: The product model and coatings system numbers listed below are based

on products by the Tnemec Company Inc. to establish the standard of quality. Equivalent products from other manufactures will be accepted provided they meet or exceed the performance of the listed products.

SURFACE / ITEM	SURFACE PREPARATION	Tnemec SHOP PRIME
METALS		
Submerged Ferrous Metals, Piping, Fittings, Valves and Equipment specified to be shop primed in their respective sections in contact with **potable water.**	SSPC-SP10 Near White Metal Blast Cleaning	Series 1 Omnithane 2 to 3 mils
Submerged Ferrous Metals, Piping, Fittings, Valves and Equipment specified to be shop primed in their respective sections.	SSPC-SP10 Near White Metal Blast Cleaning	Series 1 Omnithane 2 to 3 mils
Enclosed Ferrous Metals, Piping, Fittings, Valves and Equipment specified to be shop primed in their respective sections.	SSPC-SP10 White Metal +Blast Cleaning	Series 1 Omnithane 2 to 3 mils
Weather Exposed Ferrous Metals, Piping, Fittings, Valves and Equipment specified to be shop primed in their respective sections.	SSPC-SP6 Commercial Blast Cleaning	Series 1 Omnithane 2 to 3 mils
Enclosed Ferrous Metals.	SSPC-SP6 Commercial Blast Cleaning	Series 1 Omnithane 2 to 3 mils
Galvanized Metal Lintels and Galvanized Metals built into the masonry and concrete	SSPC-SP1 Solvent Wiping followed by SSPC-SP16 Brush Blast Cleaning	Series 66HS Epoxolime 11 3 to 5 mils
Ferrous Metals in contact with or embedded in concrete or masonry	SSPC-SP6 Commercial Blast Cleaning	Series 66HS Epoxolime 11 3 to 5 mils
All Ferrous metals concealed in wood framing and not exposed to view	SSPC-SP3 Power Tool Cleaning	Series 1 Omnithane 2 to 3 mils
All Other Weather Exposed and Enclosed Ferrous Metals, including steel frames, overhead door, steel lintels and bollards	SSPC-SP6 Commercial Blast Cleaning	Series 1 Omnithane 2 to 3 mils

NOTES:

1. Surface preparation shall be as specified within this section and as noted in the table above are minimums. Surface preparation shall be in accordance with the manufacturer's written recommendations.
2. All dry film thickness indicated are the minimum required.
3. All ferrous metals and equipment delivered to the site with shop primers other than polyamide epoxy or alkyd primer indicated above, shall receive an intermediate coat as necessary for compatibility with epoxy top coats.
4. All ferrous, nonferrous in contact with concrete or masonry and galvanized metal lintels shall receive a polyamide epoxy primer with a minimum dry film thickness of 4 mils applied to the contact area.
5. Galvanized surfaces to be painted shall be treated as required by manufacturer to be compatible with the primer and top coats specified.

END OF SECTION

SECTION 11000

EQUIPMENT - GENERAL

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Furnish, install and test all equipment specified in this Contract and as shown on the Drawings.

B. Related Work Specified Elsewhere (When Applicable):

1. Submittals are specified in Section 01340.
2. Delivery, Storage and Handling is specified in Section 01600.
3. Equipment Startup, Certification and Operator Training are specified in Section 01800.
4. Site work is specified in Division 2.
5. Concrete and grout are specified in Division 3.
6. Field painting is specified in Section 09900.
7. Surface Preparation and Shop Coatings are specified in Section 09905
8. Controls and Instrumentation are specified in Division 13.
9. Pipe, plumbing, and mechanical work are specified in Division 15.
10. Electrical work and components, and variable frequency drives, are specified in Division 16.

1.2 QUALITY ASSURANCE

A. Provide only equipment of proven reliability manufactured by reputable manufacturers.

B. Acceptable manufacturers are listed in each equipment item section in this Division. Substitute or "or-equal" equipment will be allowed only when indicated.

C. Certificates, patents, licenses or other required legalities, when applicable, are specified in each Section of this Division.

D. Manufacturer's names listed in "Acceptable Manufacturers" section of each specification are intended to indicate the type and quality of materials desired. Where the words "or equivalent" are indicated other manufacturers of equal quality, that comply fully with the specifications, are allowed. Where the words "or equivalent" are not included, the Contractor must provide equipment in compliance with the specifications that is manufactured from the listed manufacturers.

E. The Specifications and Drawings direct attention to certain required features of the equipment but do not purport to cover all details entering into its design and construction. Nevertheless, the Contractor shall furnish the equipment complete in all details and ready for operation for the intended purpose.

F. These Specifications are intended to provide standard equipment of a recognized manufacturer meeting all the requirements of the Specifications. Due to differences in such prefabricated equipment of various manufacturers, submit complete shop drawings, cuts, specifications, etc. to the Engineer to review for compliance with the Contract Documents prior to ordering any equipment. If the equipment differs materially from the dimensions given on the Drawings, submit complete drawings showing elevations, dimensions etc. for the installation. If Engineer's acceptance is obtained for alternate equipment, make any needed changes in the structures, piping or electrical systems necessary to accommodate the equipment at no additional cost to the Owner.

G. Workmanship shall be first class in all respects.

1.3 SUBMITTALS

A. Provide shop drawings and samples as specified in the General Conditions and Section 01340 of the Construction Contract. Equipment Systems Manufacturers shall integrate all required shop drawings into a common package.

B. Catalog Data: Submit manufacturer's literature and illustrations for all equipment to be installed, including dimensions, construction details, shop painting details, and materials by generic name.

C. Installation Instructions: Submit complete sets of manufacturer's instructions for each equipment item, including equipment storage requirements.

D. Complete Operation and Maintenance Manuals in compliance with Specification Section 01340.

E. Certificates: Submit manufacturer's certification that equipment, accessories and shop painting meet or exceed the Specification requirements. Submit equipment performance testing results as required by these specifications. Should the proposed equipment not comply with all the specification requirements, all deviations from the specification requirements shall be listed.

F. Submit all requirements for interface with controls and/or equipment furnished in Divisions 13 and 16. Submit wiring diagrams as required to accurately depict all such interface requirements to ensure proper operations of each system or item of equipment.

G. Provide certified bearing life calculations on all equipment bearings.

H. Submittals are further specified in this Division.

I. Guarantees/Warranties as specified below.

J. Attention is directed to the fact that the Drawings are based upon a particular piece of equipment.

K. If the equipment to be provided requires an arrangement differing from that indicated on the Drawings, the Contractor shall prepare and submit for review, detailed mechanical drawings showing all necessary changes. Such changes shall be at no additional cost to the Owner.

L. Contractor shall provide a Submittal Certification from each individual Equipment Manufacturer certifying that the Equipment Manufacturer has:

1. Reviewed the Construction Documents, the intended installation by the Contractor, and the intended functional and operational conditions;

2. Determined all conditions to be acceptable; and
3. Found no conditions which would cause the warranty to be void; or the equipment to function improperly, or not meet the performance requirements.

The submittals will not be reviewed without the inclusion of these noted certifications. Process Equipment Manufacturer Submittal Certification Form is provided in Section 01340.

M. Proposed equipment/valve identification tag information.

1.4 SEISMIC CONTROL

A. NOT APPLICABLE

1.5 GUARANTEE/WARRANTIES

A. The Contractor shall provide the Owner with a Guarantee/ Warranty for the entire project in accordance with Article 38 (General Guaranty) of the General Conditions (Division 0, Section C). No shop drawings submittals are required for this item.

B. Any specified extended warranties (i.e. those which run longer than the Contract Correction/ Warranty Period) shall be prepared in the name of the Owner and shall become effective after the completion of the Correction/ Warranty Period. The Contractor will be required to handle warranty problems during the Correction/ Warranty Period. Extended warranties shall meet the requirements specified in the relevant Section. Proposed extended warranty language shall be submitted to the Engineer for review as a part of the Shop Drawing process.

C. Equipment that is supplied by a system supplier and is intended to function as a complete and integrated system shall be warranted accordingly.

D. Any part of a mechanical equipment system that shows undue or excessive wear, or that fails due to normal operational conditions during the Correction/ Warranty Period, shall be considered as evidence of defective material or defective workmanship, and it shall be replaced with equipment or parts to meet the specified requirements at no cost to the Owner.

1.6 DELIVERY, STORAGE AND HANDLING

A. Coat all machined surfaces subject to corrosion with an easily removable rust preventive compound prior to shipment.

B. Ship fabricated assemblies in the largest sections permitted by carrier regulations, properly labeled for field erection.

C. Deliver equipment in manufacturer's original, unopened and undamaged packages, unless mounted on equipment assembly.

D. Contractor shall store and maintain all equipment in strict accordance with the manufacturer's written short term and long term storage requirements.

E. Store in a manner to protect items with epoxy shop coatings from exposure to UV light which can cause chalking of the epoxy. Length of acceptable exposure prior to providing UV protective measures shall be in accordance with coating manufacturer’s recommendations. This includes protection from UV light after installation while awaiting covering or filling of tanks, or prior to field painting for items scheduled to be top-coated

F. Should damage occur, immediately make all repairs and replacements necessary to the satisfaction of the Engineer at no costs to the Owner.

PART 2 - PRODUCTS

2.1 GENERAL DESIGN OF EQUIPMENT

A. All parts and components of mechanical equipment shall be designed for satisfactory service under continuous duty without undo wear under the specified operating conditions.

B. All parts of mechanical equipment shall be amply proportioned for all stresses which may occur during operations, and for any additional stresses which may occur during fabrication and erection. Iron castings shall be tough, close-grained gray iron casting, Class 30, in accordance with ASTM A48, latest revision. Structural steel shall conform to ASTM A36.

C. Mechanical equipment, including drives and electrical motors, unless otherwise noted, shall be supplied and installed in accordance with Occupational Safety and Health Act (OSHA) requirements. The Contractor's attention is drawn to the requirements for equipment guards. The noise level of equipment, drives and motors, unless otherwise noted, shall not exceed 90 dBA measured 3 feet from the unit under free field conditions.

D. All equipment and machinery furnished under this Contract shall be the latest improved design suitable for the service specified. All equipment and machinery shall be designed and constructed to operate efficiently, continuously and quietly under the specified requirements with a minimum of maintenance, renewals and repairs. The design and construction of all equipment and machinery shall be such as to permit operation with minimum wear, vibration and noise when properly installed.

E. Ample room for erecting, repairing, inspecting and adjusting of all equipment and machinery shall be provided. The design, construction and installation of all equipment and machinery shall conform to and comply with the latest safety codes and regulations.

F. All equipment of identical size, type and service shall be the product of the same manufacturer.

G. All equipment selected shall suit the general arrangement of the space in which it is to be installed.

H. Unless otherwise specified, electrical SCR controller units shall be furnished with the driven equipment, mounted and factory aligned, where applicable. Wiring of motors and controls shall be in accordance with the requirements of Division 16 and other applicable portions of the Specifications. Electrical variable frequency drives shall be furnished and installed by the electrical contractor, unless otherwise noted as specified in Division 16.

I. Suitable provisions shall be made for easy access for service and replacement parts.

2.2 BOLTS, ANCHOR BOLTS AND NUTS

A. Furnish all necessary bolts, anchor bolts, nuts, washers, lock washers or locking nuts, plates and bolt sleeves in accordance herewith. Anchor bolts shall have suitable washers, lock washers and, where so required, their nuts shall be hexagonal.

B. All bolts, anchor bolts, nuts, washers, lock washers, plates, and bolt sleeves shall be galvanized unless otherwise indicated below or specified elsewhere.
   1. Stainless steel hardware (minimum of Type 304, unless otherwise indicated) is required in all corrosive atmospheres, exterior areas, and/or areas with NEMA 4X or NEMA 7 rating.
   2. Stainless steel hardware (minimum of Type 316, unless otherwise indicated) is required in all submerged applications, including but not limited to the wet well and valve pit.

C. Expansion bolts shall have malleable iron and lead composition elements of the required number of units and size.

D. Unless otherwise specified, stud, tap, and machine bolts shall be of the best-quality refined bar iron. Hexagonal nuts of the same quality of metal as the bolts shall be used. All threads shall be clean cut and shall conform to AN Standard B 1.1-1974 for Unified Inch Screw Threads (UN and UNR Thread Form).

E. Anchor bolts and expansion bolts shall be set accurately. If anchor bolts are set before the concrete has been placed, they shall be carefully held in suitable templates of acceptable design. Where indicated on the Drawings, specified, or required, anchor bolts shall be provided with square plates at least 4 in. by 4 in. by 3/8 in. or shall have square heads and washers and be set in the concrete forms with suitable pipe sleeves, or both. If anchor or expansion bolts are set after the concrete has been placed, all necessary drilling and grouting or caulking shall be done by the Contractor and care shall be taken not to damage the structure or finish by cracking, chipping, spalling, or otherwise during the drilling and caulking.

F. All bolts shall be suitable size for the intended purpose, with direct input from the equipment or product manufacturer. In no case shall anchor bolt size be less than 3/8" diameter.

2.3 FOUNDATIONS, INSTALLATION AND GROUTING

A. The Contractor shall furnish the necessary materials and construct suitable concrete foundations for all equipment installed by the Contractor, even though such foundations may not be indicated on the Drawings. The tops of foundations shall be at such elevations as will permit grouting as specified below.

B. All such equipment shall be installed by skilled mechanics and in accordance with the instructions of the manufacturer.

C. In setting pumps, motors, and other items of equipment customarily grouted, the Contractor shall make an allowance of at least 1 in. for grout under the equipment bases. Shims used to level and adjust the bases shall be steel. Shims may be left embedded in the grout, in which case they shall be installed neatly and so as to be as inconspicuous as possible in the completed work. Unless otherwise permitted, all grout shall be a suitable non-shrink grout.

D. Grout shall be mixed and placed in accordance with the recommendations of the manufacturer. Where practicable, the grout shall be placed through the grout holes in the base and worked outward and under the edges of the base and across the rough top of the concrete foundation to a peripheral form so constructed as to provide a suitable chamfer around the top edge of the finished foundation.

E. Where such procedure is impracticable, the method of placing grout shall be as permitted by the Engineer. After the grout has hardened sufficiently, all forms, hoppers, and excess grout shall be removed, and all exposed grout surfaces shall be patched in an approved manner, if necessary. All foundation and grout exposed surfaces shall be given a burlap-rubbed finish and painted with at least two coats of the epoxy-based paint specified for concrete.

F. If threaded rod with lower support nuts are used to secure the equipment in place temporarily during concrete equipment pad placement, the support nuts shall be removed prior to grouting so that the threaded rod anchor bolts are not supporting the equipment and the top nuts can be tightened to secure the equipment directly to the large bedding surface provided by the non-shrink grout and concrete equipment pad. Equipment foundations shall be designed to absorb equipment vibration and transmit forces to building structure or ground. Contractor shall demonstrate that this has been completed to the RPR prior to grouting.

2.4 ELECTRIC MOTORS

A. Unless otherwise specified or permitted by the Engineer, all electric motors furnished and installed by the Contractor shall conform to the requirements hereinafter set forth.

B. All equipment motors and appurtenances (e.g., switches, instruments, etc.) shall meet the area classification and NEMA requirements as listed on Drawing E-1.

C. All motors shall be specifically designed for the installation orientation required by the equipment submitted (i.e., horizontal motor design for horizontal installation, vertical motor design for vertical installation). Universal motors shall not be allowed.

D. Ratings of Motors

1. Every motor shall be of sufficient capacity to operate the driven equipment under all load and operating conditions without exceeding its rated nameplate current or power or its specified temperature limit.
2. When the horsepower rating is specified for a motor, the motor furnished shall meet the requirements of the output specified. When the horsepower rating is not specified, the motor shall have sufficient capacity to operate the driven equipment as given in the Detailed Specifications.
3. All electric motors shall be UL recognized.
4. Motor shall have a service factor of 1.15, unless otherwise specified.

E. Type of Motors

1. All motors shall be NEMA Design B, and shall have starting characteristics and ruggedness as may be necessary under the actual conditions of operation and, unless otherwise specified, shall be suitable for full-voltage starting.
2. Motors shall be manufactured by General Electric Co., Reliance, Toshiba, Siemens, or be an equivalent product, that meets all the requirements herein.
3. All motors shall have Class F insulation with temperature rise in accordance with NEMA Standards for Motors and Generators and based on a maximum ambient temperature of 40 deg. C.

4. Motors Installed in Class I/ Division 1 Hazardous Locations:
    a. Motors shall be explosion-proof (XP) rated for Class I/ Division 1/ Group C and D rated for hazardous locations and shall meet the requirements of the National Electric Code and other safety codes pertaining thereto.
    b. Motors shall include integral high temperature thermostats or similar device with a high temperature interlock to shut down the motor and auxiliary contact to activate an alarm condition.
    c. Thermostats shall be normally closed, hermetically sealed and rated a minimum of 0.5A at 120 VAC. The thermostats shall be set so that the temperature of the motor will not exceed the auto-ignition temperature for a Class I/ Division 1/ Group C and D location.
5. Motors Installed in Class I/ Division 2 Hazardous Locations:
    a. Motors shall be either explosion-proof (XP) rated for Class I/ Division 1/ Group C and D or Class I/ Division 2 Group C and D locations. Motors may be TEFC rated; however, TEFC motors used in hazardous areas shall be non-sparking type (brushless) and shall have non-sparking cooling fans. All motors shall meet the requirements of the National Electric Code and other safety codes pertaining thereto.
    b. Motors shall include integral high temperature thermostats or similar device with a high temperature interlock to shut down the motor and auxiliary contact to activate an alarm condition.
    c. Thermostats shall be normally closed, hermetically sealed and rated a minimum of 0.5A at 120 VAC. The thermostats shall be set so that the temperature of the motor will not exceed the auto-ignition temperature for a Class I/ Division 2/ Group C and D location.

F. General Design of Motors
1. Motors shall comply with the latest NEMA Standards for Motors and Generators, unless otherwise specified. Motors shall not run beyond nominal full speed rpm.
2. Motor windings shall be braced to withstand successfully the stresses resulting from the method of starting. The windings shall be treated thoroughly with acceptable insulating compound suitable for protection against moisture and slightly acid or alkaline conditions.
3. Bearings shall be of the self-lubricating type, designed to ensure proper alignment of rotor and shaft and to prevent leakage of lubricant.
4. Bearings for open motors shall be of the sleeve or ball type, as specified under the respective items of mechanical equipment. Bearings for totally enclosed and explosion-proof motors shall be of the ball type. The exception to this shall be belt-drive applications in which case the motor manufacturer shall determine if roller bearings are required in lieu of ball bearings due to higher radial loads.
5. Vertical motors shall be provided with thrust bearings adequate for all thrusts to which they can be subjected in operation.

6. Vertical motors of the open type shall be provided with drip hoods of acceptable shape and construction. When the drip hood is too heavy to be easily removed, provision shall be made for access for testing.
7. All motors installed above or within potable water storage tanks shall use food grade lubrication that is NSF approved.

G. Single-Phase Motors with Auxiliary Devices
1. Single-phase motors requiring switching devices and auxiliary starting resistors, capacitors, or reactors shall be furnished as combination units with such auxiliaries either incorporated within the motor housings or housed in suitable enclosures mounted upon the motor frames. Each combination unit shall be mounted upon a single base and shall be provided with a single conduit box.

H. Motor Terminal Boxes and Leads
1. Motors shall be furnished with oversize conduit terminal boxes to provide for making and housing the connections and with flexible leads of sufficient length to extend for a distance of not less than 4 inches beyond the face of the box. The size of cable terminals and conduit terminal box holes shall be as permitted by the Engineer. An acceptable type of solderless lug shall be furnished. Totally enclosed and explosion-proof motors shall have cast-iron terminal boxes.

I. Submersible Motors
1. Motors which are rated for submersible use shall be of the highest efficiency in the industry for this type of motor and horsepower rating.
2. When used in conjunction with variable frequency drive equipment, the submersible motor shall be rated for inverter duty with Class H insulation.

2.5 DRIVE COUPLINGS

A. Couplings shall be all metal, flexible, designed for both angular and parallel misalignment, provided with a guard, and provided with a means for lubrication.

B. Close-coupled connections shall have machined shouldered joints for motor and pump motor support.

C. High torque couplings shall be all metal gear couplings with external grease fittings. A service factor of 1.50 shall be used based on the motor nameplate rating.

2.6 LUBRICATION FITTINGS

A. All lubrication fittings shall be brought to locations that are readily accessible to operators from normal operating walkways or platforms. Equipment lubrication fittings shall be extended to outside of all equipment so that they are readily accessible from the outside without the necessity of removing covers, plates, housings, or guards, floor plating or other obstruction, and to eliminate creating falling hazards by unusual elevations. Fittings shall be buttonhead type. Lubrication fittings shall be mounted together wherever possible.

B. Pressure grease-lubricated fittings shall be the "Zerk Hydraulic" type or the "Alemite" type.

C. Housings of grease-lubricated bearings shall be automatically exhausted to the atmosphere to prevent excessive greasing.

D. Oil drains shall be piped to a location outside the equipment frame for ease of draining. Provide ball valve for positive shutoff. Pipe shall be type-L copper or galvanized steel.

2.7 SPARE PARTS AND SPECIAL TOOLS

A. For each type of equipment furnished, the Contractor shall provide spare parts, as specified on the respective sections of the Division, and a complete set of all special tools (including grease guns or other lubricating devices) which may be necessary for the adjustment, operation, maintenance, and disassembly of such equipment.
B. Tools shall be high-grade, smooth, forged, alloy, tool steel. Grease guns shall be lever type.
C. Special tools are considered to be those tools which because of their limited use are not normally available, but which are necessary for the particular equipment.
D. All spare parts and special tools shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts and special tools until completion of the work, at which time they shall be delivered to the Owner.
E. Spare parts shall be appropriately labeled and containerized, and shall be properly packaged for long-term storage.
F. If the Contractor utilizes a spare part to remedy an issue during the Contract work (through Final Completion) they shall replace the spare part at no additional cost to the Owner.

2.8 EQUIPMENT DRIVE GUARDS

A. All equipment driven by open shafts, belts, chains, or gears shall be provided with all-metal or rigid fiberglass OSHA approved guards enclosing the drive mechanism. Guards shall be securely installed but shall be removable with quick open latches.
B. Guards shall be constructed of galvanized sheet steel or galvanized woven wire or expanded metal set in a frame of galvanized steel members, unless otherwise specified.
C. Guards shall be secured in position by steel braces or straps which will permit easy removal for servicing the equipment.
D. The guards shall conform in all respects to all applicable safety codes and regulations.

2.9 PROTECTION AGAINST ELECTROLYSIS

A. Where dissimilar metals are used in conjunction with each other, suitable insulation shall be provided between adjoining surfaces so as to eliminate direct contact and any resultant electrolysis.
B. The insulation shall be bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers, or other acceptable materials.

2.10 NAMEPLATES

A. Each piece of equipment shall be provided with a substantial nameplate of noncorrodible metal, securely fastened in place and clearly and permanently inscribed with the manufacturer's name, model or type designation, serial number, principal rated capacities, electrical or other power characteristics, and similar information as appropriate.

B. An enlarged paper copy of all the nameplate data on equipment and motors shall be provided in the Shop Drawings and Operation and Maintenance Manuals.

2.11 SURFACE PREPARATION AND SHOP COATINGS

A. Provide surface preparation and shop coatings in accordance with Specification Section 09905.

2.12 ELECTRICAL CONTROLS

A. Additional controls for various items of equipment are specified under Division 13 and/or Division 16, as indicated on the Drawings, and as specified. Due to potential differences in electrical requirements for equipment of various manufacturers, the Contractor shall coordinate the electrical requirements of the equipment supplied with the work specified in Division 13 and/or Division 16.

B. Provide auxiliary contacts as required for remote status and alarm conditions. Contractor shall coordinate each piece of equipment. Refer to the Electrical and Instrumentation Drawings.

C. Electrical controls for all equipment shall comply with the requirements of Division 16 and the National Electric Code, including provisions to allow each piece of equipment to be locked out/tagged out for maintenance or repairs.

D. Control panels shall be constructed in conformance with UL 508A and bear the UL 508A seal confirming the construction. UL inspection and seal application can be accomplished at the panel fabrication facility or by field inspection by UL inspectors. Obtaining the UL seal and any inspections shall be provided at no additional cost to the Owner.

2.13 EQUIPMENT AND VALVE IDENTIFICATION TAGS

A. All new process equipment and valves shall be identified by a color-coded identification valve tag provided and installed by the Contractor. The tags shall be provided with identifying numbers and letters to match those as shown on the Drawings. Contractor shall submit a complete list of proposed Identification Tag information and it shall be reviewed/confirmed with the Engineer and Owner through the submittal process prior to ordering any tags. In general, tag information shall match the information provided on the Drawings.

B. All identification tags shall be provided with sufficient lengths of chain for attachment to the respective equipment and/or valve.

C. Tags shall conform to the following specifications:

1. The tags shall be 2.5-inch diameter, 1/16" thick, rigid, multi-layered sandwich laminate with contrasting inner and outer colored acrylic plastic layers. Top hole size is 5/32" for hanging tags.
2. Tags shall be available in 7 different outside colors. Owner and Engineer shall select up to 4 different colors for the project.
3. Tags shall have up to three lines engraved on a side and eight characters per line of identification information. Tags shall be engraved one side.
4. Tags shall be secured to valves with nylon cable ties or adjustable metal bead chain. Securing method shall be selected by the Owner and Engineer.
5. Tags secured to equipment shall be fastened to a flat visible surface by a minimum of two SS screws or SS pop rivets.

6. Tags shall have a service temperature of -40°F to 175°F
7. Manufactured by Seton Name Plate Corporation, New Haven, CT, Brimar Industries, Garfield, NJ or equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Contractor shall carefully inspect receiving structures and anchor supports for defects in workmanship prior to equipment arrival.

B. Contractor shall carefully inspect all equipment for:
   1. Damage in shipping.
   2. Defects in workmanship and materials.
   3. Tightness of all nuts and bolts.

C. Inspection shall include, but not be limited to, the following as applicable:
   1. Soundness (without cracked or damaged parts).
   2. Correctness of setting, alignment, and relative arrangement of various parts.
   3. Adequacy and correctness of packing, sealing and lubricants.
   4. Completeness in all details, as specified.

D. Field Quality Control
   1. As part of the equipment cost, the Contractor shall provide the services of a duly authorized Manufacturer's representative to assist the Contractor with equipment adjustment, start-up, and necessary testing to prove that the equipment is in proper and satisfactory operating condition.
   2. On completion of the work, the Manufacturer's representative shall provide written certification that the equipment conforms to the requirements of the Contract and is ready for permanent operation and that nothing in the installation will render the manufacturer's warranty null and void, as outlined in the attached equipment certification form.
   3. As part of the startup services, the Manufacturer's representative shall provide the Owner's personnel with training in the proper operation and maintenance of all associated equipment. The equipment training certification form shall be used for this purpose.
   4. When the work is substantially complete the Contractor will be required to demonstrate, to the satisfaction of the Engineer, the ability of all equipment to operate as intended without defect including binding, vibration, jamming, overheating, etc.
   5. All equipment found defective by the Engineer shall be replaced by the Contractor at no expense to the Owner.

3.2 PREPARATION

A. Provide all required adhesives, sealants, insulation, lubricants, waterproofing, fireproofing or other protection specified in each Section of this Division.

3.3 INSTALLATION

A. Contractor shall install equipment in accordance with Manufacturer's requirement. Manufacturer(s) shall work with the Contractor to ensure that the equipment has been

properly installed.

B. Do not install equipment until all defects or inadequacies in receiving structure have been corrected to meet Specifications.

C. Erect and lubricate equipment in strict accordance with the manufacturer's instruction. Installation shall include all oil and grease required for proper operation.

D. All equipment mechanisms shall withstand all stresses that may occur during fabrication, erection, and intermittent or continuous operation.

E. Contractor to furnish and install supports as indicated on the Drawings, and as required by the equipment manufacturer.

F. Thoroughly clean all equipment and appurtenant piping to remove all dirt, grease, mill scale, and other foreign matter and touch up factory finish to the satisfaction of the Engineer.

3.4 STARTUP AND TESTING

A. Test and adjust all equipment in accordance with the general requirements of Specification Section 01800, and the specific requirements of the various Division 11 Specification Sections.

B. Demonstrate the equipment's ability to operate without overloading jamming, excessive vibration, etc. during normal operation conditions.

C. Demonstrate the equipment's ability to meet all the performance requirements specified for the equipment system to make a complete operational system, suited for its intended use.

END OF SECTION

SECTION 11310

PUMPS - GENERAL

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:
   1. Furnish, install, test and place into satisfactory operation pumping equipment and appurtenances as shown on the Drawings, as specified herein and as required for a complete installation.
   2. Contractor will perform pump tests in the Engineer's presence to indicate that pump efficiency, capacity, and discharge head conform to specifications in Pump Schedule in this Division.

B. Related Work Specified Elsewhere (When Applicable
   1. Additional requirements in Sections 01800 and 11000.
   2. Surface preparation and shop coatings are specified in Section 09905.
   3. Field Painting is specified in Section 09900.
   4. Instrumentation is specified in Division 13.
   5. Piping and valves are specified in Division 15.
   6. Electrical is specified in Division 16.

1.2 QUALITY ASSURANCE

A. In accordance with the requirements of Section 11000.

B. All pumping equipment shall be designed, constructed, installed and tested in accordance with the best practice and methods and the standards of the Hydraulic Institute.

C. Additional performance requirements are outlined in pump specifications.
   1. Pumps shall meet all performance requirements listed in this specification, and associated specifications.
   2. In the event that the pump(s) equipment fails to meet the performance requirements specified, the Engineer shall have the right to require the Manufacturer to modify or replace the pumping equipment to enable said system to meet the performance requirements specified.
   3. A second test, and any subsequent tests as may be necessary to ensure compliance with the Specifications shall be performed at no additional cost to the Owner.
   4. All costs arising from project delays caused by failure to meet the performance requirements specified herein shall be borne by the Manufacturer and shall be responsible to the Contractor for any liquidated damages incurred due to any delay in passing all factory testing.

D. Only pumping units having wire-to-water efficiencies within a reputable manufacturer's equipment range of efficiencies will be accepted.

1.3 SUBMITTALS TO THE ENGINEER

A. In accordance with the requirements specified in Section 01340 and 11000. Submit such shop drawings, manufacturer's literature, short-term and long-term storage requirements, and operations and maintenance manuals.

B. Submit the following information for all pumps specified:

1. Manufacturer's rating curves showing the following pump characteristics for each unit of flow:
   a. Total dynamic head.
   b. Brake horsepower.
   c. Efficiency.
   d. Required net positive suction head.
   e. Allowable suction lift.
2. Variable speed units:
   a. Variable speed curves with at least five speeds plotted from maximum RPM to minimum RPM required to obtain the minimum pump flows at the heads indicated in the pump schedule.
3. Literature, layout drawings and typical specification describing pumping equipment, showing all important details of construction and dimensions.
4. Maintenance instructions shall be furnished to indicate operation, assembly, disassembly and troubleshooting.
5. Mechanical seal drawing shall be furnished indicating service conditions, materials of construction, and basic interface dimensions.
6. Literature and Layout Drawing for the pump seal water system supply and drain piping.
7. Literature, Schedule and Layout Drawing for pump Gauge assemblies.

C. After fabrication and prior to shipment, shop test completed pump and motor assemblies indicated in the Pump Schedule for performance in accordance with the Hydraulic Institute Standards and submit certified copies of the pump and motor performance data furnished.

1.4 DELIVERY, STORAGE, AND HANDLING

A. In accordance with the requirements of Section 11000. Manufacturer shall deliver equipment to the project site where and when directed by the Contractor.

1.5 WARRANTY

A. In accordance with the requirements of Section 11000.

PART 2 - PRODUCTS

2.1 PUMPING SYSTEM

A. General:

1. Pump:
   a. Pump type and use are specified in Pump Schedule in this Section.
   b. See the Specification Section noted in the Pump Schedule for additional information for each specific pump type.

c. Pump shall be suitable for intended purpose as specified and as shown on Drawings.
d. Pumps designated for a certain function shall be supplied by same manufacturer.
e. Pumps for all functions need not be supplied by the same manufacturer.
f. All parts shall be designed and proportioned to have liberal strength, stability and stiffness to perform required function.
g. Provide ample room and fittings for inspection repairs and adjustments.
h. Pump base accurately aligned, sized and rigidly anchored into position in accordance with Drawings.
i. Anchor bolts, plates, nuts and washers shall be SAE bolt type 316 stainless steel of ample size and strength for purpose intended, furnished and installed by Contractor in accordance with manufacturer's instructions.
j. Provide adaptor flanges, as necessary, to match piping system.
k. Brass or stainless steel name plates providing manufacturer's name, rated capacity, total dynamic head, operating speeds and other pertinent data shall be attached to pump equipment.

2. Motors:
   a. Refer to requirements in Section 11000.
   b. Type specified in the Pump Schedule in this Division.
   c. All motors shall be of nationally known manufacturer and conform to NEMA standards and specifications.
   d. Maintain sufficient capacity to operate pump throughout designated operating range without exceeding name plate rating for current and power.
   e. Vertical motors provided with radial keyways to absorb thrust caused by the shafting.
3. Lifting Cable:
   a. Each pump shall be equipped with a stainless steel lifting cable of adequate lifting capacity for the pumps supplied. The cable length shall be adequate to extend a minimum of 15-feet above the top of the wet well to allow connection to lifting equipment. Terminate upper end of cable with a swag ball end for easy connection to the portable hoist.
   b. Install a stainless steel hook bolt below the top of the tank within reach of the access hatch for storage of the excess cable.
4. Surface Preparation and Shop Coatings
   a. Provide surface preparation and shop coatings in accordance with Specification Section 09905.
5. Field Coatings
   a. Provide field coatings in accordance with Specification Section 09900.
6. Spare Parts:
   a. Spare parts shall be delivered at the same time as the equipment to which they pertain.
   b. The Contractor shall properly store and safeguard such spare parts until Substantial Completion of the work, at which time they shall be delivered to the Owner.

c. Parts shall be packaged in individual suitable containers labeled with the part number, name and quantity.

2.2 PUMP SCHEDULE

A. Wastewater Pumps: Section 11319

1. Location: Marjorie Street Pump Station wetwell
2. Function: Pump raw wastewater
3. Number of Units: Two (P-1, P-2) (one lead, one standby)
4. Type: Submersible, non-clog, Explosion-Proof Rated, Class 1, Division 1, Group D.
5. Capacity: Each pump shall be capable of meeting the following operating conditions:
   a. 120 GPM @ 45-ft TDH with a minimum efficiency rating of 49.4%
   b. Minimum shut-off head: 79 feet
6. RPM: 3445 RPM.
7. Seal: As specified in Section 11319
8. Drive: Variable frequency drives (provided under Division 16)
9. Motor: 4 HP, 230 V, 3 Ø, 60 Hz. Inverter Duty Rated.
10. Control: Control shall be as specified in Section 11319 and 13440.
11. Discharge outlet: 3-inch diameter

PART 3 - EXECUTION

3.1 EXAMINATION, PREPARATION AND INSTALLATION

A. In accordance with the requirements of Section 11000 and the manufacturer's written instructions.

3.2 START UP AND TESTING

A. In accordance with the requirements of Section 01800 and 11000.

B. Perform all adjustments necessary to place equipment in satisfactory working order and to meet performance testing requirements. If equipment fails to meet performance requirements, the Contractor shall modify or replace the equipment at no additional cost to the Owner.

3.3 CLEANING AND FIELD COATINGS

A. In accordance with the requirements of Section 11000.

3.4 TRAINING AND WARRANTY PERIOD SUPPORT

A. In accordance with the requirements of Section 01800.

END OF SECTION

SECTION 11319

SUBMERSIBLE NON-CLOG CENTRIFUGAL PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Furnish, install and test submersible non-clog centrifugal pumps, and all appurtenances necessary to make a complete and operable system as indicated in the Specifications and as shown on the Drawings.

B. Related work specified elsewhere:
   1. Additional requirements are specified in Sections 01800, 11000 and 11310.
   2. General Requirements are specified Division 1.
   3. Concrete and grout are specified in Division 3.
   4. Surface Preparation, Shop and Field Coatings are specified in Division 9.
   5. General Pump System Requirements and Pump Schedule are specified in Section 11310.
   6. Instrumentation and Controls are specified in Division 13.
   7. Pipe, fittings and valves are specified in Division 15.
   8. Electrical is specified in Division 16.

C. Each pump shall be capable of continuously pumping raw unscreened wastewater at all flow and head conditions indicated in the pump schedule, and along the pump curve

1.2 QUALITY ASSURANCE

A. Qualifications of the Manufacturer:
   1. The pumps complete with all appurtenances forms an integrated system, and as such shall be supplied by one pump manufacturer who shall provide all the equipment and appurtenances, regardless of manufacturer. The Contractor shall be responsible for the satisfactory operation of the entire system.

B. Acceptable Manufacturers:
   1. Flygt Corporation, Norwalk, CT
   2. KSB Inc., Richmond, VA
   3. Or Equal

PART 2 - PPRODUCTS

2.1 MATERIALS

A. General:
   1. All pumps designated for a certain function shall be supplied by the same manufacturer.
   2. All parts shall be designed and proportioned to have liberal strength, stability, and stiffness to perform required functions.
   3. Exposed hardware shall be stainless steel.
   4. Provide ample room and fittings for inspection, repairs and adjustments.

5. Pumps shall pass rags and any trash or stringy material which may pass through the average house collection system.
6. Pumping units shall draw raw, unscreened wastewater from a wet well and discharge into a 4-inch forcemain as specified in Section 11310.

B. Pump Support System
1. Pumps shall be mounted on a substantial guide rail system, with slide away coupling base/discharge elbow.
2. The lower guide holders shall be integral with the discharge connection and shall be anchored to the wet well floor by means of stainless steel anchors.
3. Pump base accurately aligned, sized, and rigidly anchored in position in accordance with the manufacturer's requirements and recommendations and allow for complete removal of each pump.
4. Sealing of pump to discharge connection shall be by means of metal to metal contact.
5. No portion of the pump shall bear directly on the floor.
6. There shall be two non-sparking guide rails per pump which shall be a minimum of 2-inch diameter stainless steel pipe.
7. Slide-away coupling shall be designed so that when pump is idle, it may be removed for service or inspection and then returned to service without entering the wet well to unbolt or unlock the connection between the pump and piping.

C. Submersible Non-Clog Sewage Pumps: The submersible non-clog sewage pumps shall be capable of pumping wastewater at the conditions indicated in the pump schedule and shall conform to the requirements specified.

D. Pump Casing:
1. Constructed of gray cast iron, Class 35B (ASTM A48) of ample thickness, capable of prolonged resistance to the abrasive action of solids or foreign matter contained in the liquid passing through the pump. All exposed nuts or bolts shall be stainless steel.

E. Discharge Nozzles: Minimum size and type indicated in the Pump Schedule.

F. Mix Flush Valve:
1. The pumps shall come with mix flush valves with a 90 degree discharge elbow.
2. The valve shall be safe and suitable in hazardous locations Class 1, Division 1, Groups C and D.
3. The flush valves shall transform the pump into a jet stream mixer during the first 20-40 sec (adjustable) of a pumping period. The flush valve function shall be based on the ejector principle and the operation shall be automatic and induced by the pump flow and pressure. No electrical components or extra cabling will be accepted.

G. Impeller:
1. The submersible non-clog sewage pump impeller shall be semi-open, non-clog, dynamically balanced, made of cast iron, ASTM A532 Class III Type A.
2. The leading edge of the impeller shall be hardened to a minimum 45 HRC and shall be capable of handling solids, fibrous material, rags and other material normally found in wastewater. Non-clog impellers that do not have the ability to cut solids must be capable of passing a 3-inch solid.

3. Impellers shall be attached to shaft by a streamlined impeller bolt or equally efficient method, capable of withstanding a pump reversal to full runaway speed, but still permit easy removal.

H. Shaft: The pump-motor shaft shall be stainless steel, accurately machined.

I. Seal: The pump shaft seal shall be of the double mechanical type, with pump seal leak detection system as specified hereinafter.
   1. The pump shaft seal shall be of the double mechanical type, with pump seal leak detection system as specified hereinafter.
   2. The lower seal shall contain a tungsten carbide rotating face against a tungsten carbide stationary face. The upper seal shall contain a tungsten carbide rotating face and a tungsten carbide stationary face.
   3. An electric sensing probe shall be mounted in the seal chamber to detect any water leakage past the lower seal. The sensor shall activate a "Seal Fail" alarm light at the control panel. The manufacturer shall provide a control and status relay for each pump to be mounted in the pump control panel.

J. Motor:
   1. Submersible non-clog sewage pump motor ratings shall be as specified in the preceding Pump Schedule, Section 11310.
   2. Squirrel-cage, induction, shell type design housed in an oil-filled or air-filled, water tight chamber, NEMA Design B.
   3. Motors shall have normal starting torque and low starting current.
   4. Motors shall maintain sufficient capacity to operate pump throughout designated operating range without exceeding name-plate rating for current and power.
   5. Pump motors shall be furnished with ball bearings.
   6. Vertical motors shall be provided with radial keyways to absorb thrust caused by the shaft.
   7. The motor shall be fitted with heavy lifting eyes, each capable of supporting the entire weight of the pump and motor.
   8. An electric sensing probe shall be mounted in the seal chamber, and be connected to a red signal light on the control panel to detect any water leakage past the outer seal.
   9. A heat sensor thermostat or thermal switches shall protect motor against excess heat in compliance with its U.L. Class I, Group D rating. Should high temperature occur, the thermal switches shall open, stop the motor and activate an alarm at the pump control panel. Sensor shall reset automatically at the motor when motor cools with manual reset at the control panel.
   10. Controls are specified in Section 13440. Refer to the Instrumentation and Electrical Drawings.

K. Spare Parts:
   1. Spare parts shall be delivered at the same time as the equipment to which they pertain.
   2. The contractor shall properly store and safeguard such spare parts until completion of the work, at which time they shall be delivered to the Owner.
   3. Parts shall be packaged in individual suitable containers labeled with the part number, name and quantity.

4. Spare parts shall include:
   a. Two complete sets of gaskets per each type pump.
   b. Any special tools required to service the equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. In accordance with Specification Section 11000.

3.2 START-UP AND TESTING

A. In accordance with Specification Sections 01800 and 11000.
B. After installation of the equipment is complete, the Contractor will operate and test each unit in the presence of the Engineer.
C. The Contractor shall provide all labor, piping, equipment, and materials necessary for conducting tests.
D. The Contractor shall check the motors and insulation for moisture content and defects.
E. The Contractor shall operate each pump unit to demonstrate its ability to pump without excessive vibration, motor overloading, or overheating. During the test the Contractor shall record pump capacity and motor input.
F. Each pump shall be operated for a sufficient period to permit thorough observation of all pump components and controls.
G. Repeat tests until results obtained meet the Engineer's approval.
H. Make all adjustments necessary to place equipment in satisfactory working order made at the time of testing.

END OF SECTION

SECTION 13410

INSTRUMENTATION AND PROCESS CONTROL GENERAL

PART 1 - GENERAL

1.1 DESCRIPTION

A. General Requirements and Definitions:

1. A single System Integrator (SI) shall furnish all services and equipment as specified herein and in the following Specification sections:

Section	Title
13440	Instruments
13441	Control Narratives
13444	Control Panels

2. The System Integrator (SI) provide all labor, materials, equipment, operations, methods and procedures as indicated in the Contract Documents to achieve a fully integrated and operational system. The SI shall be responsible for integrating hardware into the Division 13 control panels, local control panels, and instruments.
3. Items specifically excluded from the scope of the System Integrator include the following:
   a. Programming and configuration of the Programmable Logic Controllers (PLCs), Operator Interface Terminals (OITs), and the SCADA system as defined in section 13441 shall be done by the Application Engineering Services Supplier (AESS). The Contractor shall coordinate with the AESS as outlined herein and in Section 13441.
      i. The AESS shall be Electrical Installations, Inc.
4. All systems indicated in the Contract Documents shall mean all necessary supervision, labor, equipment, and materials required to provide complete, properly integrated systems.
5. All hardware systems shall be adjusted, tested, inspected, and optimized to the satisfaction of the Engineer and Owner prior to being turned over to the Owner.
6. The words "provide", "supply", "supply and install", "install", "furnish" or "furnish and install" shall mean a complete and properly functioning hardware installation performed by the System Integrator unless otherwise noted. The System Integrator shall design and coordinate the Instrumentation & Process Control system for proper operation with related equipment, materials, and labor (AESS) furnished by others under other sections of these Specifications and with related existing equipment.
7. Refer to Civil, Mechanical, Instrumentation, and Electrical Drawings to coordinate material and equipment locations. Refer to the Process Drawings for locations and connection to primary instrumentation, control valves and process equipment. Refer to the Electrical Drawings for the location of transmitters, control stations, motor drives and centers, variable speed drives, control panels, wiring diagrams, network, and computer equipment.

B. Work Included:
   1. Refer to Paragraph 1.1.A.1 for list of specifications.
   2. Application Development:
      a. The AESS, will provide PLC programming, SCADA programming, and IP addresses for all network equipment for equipment control or connection to control, status indication and alarm annunciation of equipment as shown in the Instrumentation Drawings, and described in Section 13441 – Control Loop Descriptions. Programming shall also be in accordance with 13442.
      b. Network switch and router configuration shall be the responsibility of the SI.
      c. The Contractor, SI, and AESS shall coordinate the schedule the work of this project. Contractor schedule to accommodate the AESS to follow systems through and limit the amount of simultaneous systems being worked on at any given time.
   3. Application Development: Refer to Section 13441
   4. Meetings:
      a. The SI shall attend a Pre-Instrumentation meeting with the Contractor, Engineer, and others prior to the submission of any specifications.
      b. The SI shall attend construction meetings as necessary to coordinate construction sequencing.
      c. The AESS shall attend construction meetings as necessary to coordinate construction sequencing.
   5. Miscellaneous:
      a. Furnish and install all transducers, media converters, protocol converters, terminals, transformers, interposing or pilot relays (for both new and existing equipment), signal transmitters, signal splitters/boosters, intrinsic safety barriers, power supplies, power supply connections and other miscellaneous instrumentation required to make a complete system for new and existing equipment.
      b. Furnish and install all vendor or manufacturer cables and appurtenances between primary instruments and the transmitters, receiving instruments or destination terminals. All methods, materials and supplies will meet the requirements of Division 16.
      c. Furnish mounting hardware for each instrument. The System Integrator will provide information on the proper installation in accordance with the Manufacturer's requirements for each instrument and shall supervise the installation. Tubing, process taps, and an isolation valve will be provided under Mechanical in Division 11 and 15. Coordinate the size and type of connection required. Refer to the Instrument Installation Detail Drawing in the Contract.
   6. O&M Documentation:
      a. Provide complete O&M documentation as listed under paragraph 1.4 and other related Division 13 specifications.
   7. Demolition:
      a. Remove and/or relocate existing equipment as indicated on the Drawings.

b. Deliver PLC, OIT, and communications equipment not reused to Owner.

8. Coordination:
   a. Process Instrumentation and Process Control Systems will be provided under Division 11, where specified. The System Integrator shall coordinate with the instrumentation and control systems provided under these sections.
   c. Conduit and wiring (excluding integral or vendor furnished cables and fiber optics) shall be provided and tested under Division 16 and as shown on the Electrical Drawings.
   d. The SI shall provide the drawings as specified in Section 13444 to be used by the Electrical Contractor as a wiring aid.
   e. Provide manufacturer recommended installation and mounting requirements for each instrument to be connected to process equipment, piping or fittings requiring a process connection such as NPT taps, sample piping and process line insertion. The System Integrator will supervise and provide guidance on proper installation of instrumentation equipment. This shall include manufacturer's recommended mounting installation heights and locations for gas detection sensors, clearances for level sensors per manufacturer's blanking distance, etc.
   f. If the Division 11 provided PLC's communication protocol does not match that of the PLC being provided by the Division 13 System Integrator, the System Integrator shall provide a protocol converter as specified in Section 13445. The System Integrator shall provide communication parameters and network addresses to the Division 11 control panel manufacturer. The Division 11 control panel manufacturer shall coordinate communication and programing requirements with the Division 13 System Integrator prior to programing effort. Any programming and network configuration changes shall be done to provide network communication shall be provided at no cost to the Engineer and Owner.

C. Related Work Specified Elsewhere:
   1. Coordination is specified in Division 1.
   2. Manufacturer's control systems for process equipment are specified in Division 11.
   3. Control Valve Actuators are specified in Division 15.
   4. HVAC Control Systems are specified in 15604.
   5. Electrical Systems are specified in Division 16.

D. Related Work by Others under this Contract:
   1. Local control stations (including E-stops, local hand switches, speed pots, and local indicating lights) and equipment control panels (i.e., MCCs, VFDs), indicated on Electrical Drawings.

E. Demonstration of Complete Instrumentation and Process Control System:
   1. The Owner will assume no liability or responsibility for any portions of the installation under this Contract until they are demonstrated by the Contractor and accepted by the Engineer in writing. Final demonstrations shall be made

only after the Engineer is satisfied that the work has been completed in accordance with the intent of the Contract Documents.

2. After the Instrumentation and Process Control System is completed, and when directed by the Engineer, demonstrate the total system operation, and make final adjustments to the system. If any system or piece of equipment within a system fails to function properly, rectify such defects or inadequacies, and make a final demonstration as directed by the Engineer.
3. Provide the services of authorized manufacturers' representatives to instruct the Owner's representatives in the proper operation of each partial or complete system installed under this Contract where noted.
4. Pay all charges or fees, including the cost of any special test equipment, factory engineers, etc., necessary for the proper performance of the specified tests, demonstrations, and instructions.
5. All demonstrations and instructions referred to shall be scheduled at the convenience of the Engineer and the Owner and in no case shall be scheduled without at least 72 hours written notice to the Engineer. Scheduling of testing and certification of equipment by the Engineer until all instrumentation and electrical equipment have been installed, calibrated including testing/transmitting of alarms, status, etc have been performed in the field in accordance with the Specifications. Once the systems have been tested in the field, the Contractor shall notify the Engineer a minimum of 72 hours before a formal startup and testing of each location. All testing of the equipment or system(s) shall be performed in a single contiguous block of testing dates or as agreed upon by the Engineer.
6. Service calls:
    a. Provide system integrator services of one (1) 8-hour working day (not including travel time) upon request of the Owner within the first year of operation. Unused time shall be issued to the Owner as a credit.

F. Removals, Relocations and Rearrangements:
1. Examine the existing site for the work of all trades, which will influence the cost of the work under Division 13. This work shall include removals, relocations and rearrangements relating to the work of all trades which may interfere with, disturb or complicate the performance of the work under Division 13; and relating to the work involving systems, equipment and related service lines which shall continue to be utilized as part of the finished project.
2. Provide in the bid a sufficient amount effort to include all removals, relocations, rearrangements and reconnections herein specified, necessary or required to provide approved operation and coordination of the combined new and existing systems and equipment.

1.2 QUALITY ASSURANCE

A. All materials provided under this Contract shall be equal in quality, appearance and performance to that specified herein and shall be subject to the approval of the Engineer. Verify the availability of all materials proposed to be used in the execution of the work prior to submitting same for the Engineer's approval. Supply chain issues or the discontinuance of production of any material or product after approval has been granted shall not relieve the Contractor from furnishing an Engineer approved

alternate of comparable quality, function, and design without additional cost.

B. Materials and equipment furnished under this Contract shall be standard products of manufacturers regularly engaged in manufacture of such products and shall be manufacturer's latest standard design that complies with Specification requirements. Products shall essentially duplicate material and equipment that have been in satisfactory local use at least three years.

C. Materials and equipment with any chipset furnished under this Contract shall be purchased and supported by the manufacturer or by an authorized manufacturer's representative.
   1. A certificate of authenticity or manufacturers manifest shall be provided at Engineers request.

D. Material and equipment furnished under this Contract shall disallowed for use by any applicable government agency (E.g., EPA, DHS, etc.) for use with critical infrastructure (E.g., the National Defense Authorization Act of 2018 banned the use of Hikvision).

E. The Contractor shall have supplied comparable systems to those specified herein and shall maintain engineering and service departments capable of designing and maintaining these systems. Provide for a period of 12 months from the date of final acceptance of the work, all necessary supervision, labor, materials, and equipment, in order to correct any defects in any system due to faulty materials, equipment, installation methods, or workmanship and consequent damage resulting from such defects. This work shall be scheduled during normal working hours and at the convenience of the Owner.

F. System Integrator:
   1. The Contractor's attention is directed to the fact that the instrumentation is an integrated system and as such, shall be furnished by one supplier, who shall provide all of the equipment and appurtenances regardless of manufacturer, and be responsible to the Contractor for satisfactory operation of the entire system provided. Substitutions on functions specified will not be acceptable.
   2. The exception shall be where instrumentation and control packages are furnished by respective equipment manufacturers as required in Division 11, 14, 15, and 16. All necessary provisions will be made to ensure a proper signal and communication interface as indicated on the P&IDs and associated equipment specifications between the main process instrumentation and control packages specified within this section and those provided. The Contractor shall provide startup reports which demonstrate proper operation of Division 11, 14, 15, and 16 equipment and associated Division 11 control systems.

G. Acceptable System Integrators:
   1. AEC Engineering, Freeport, ME
   2. Electrical Installations Inc., Moultonborough, NH
   3. I&C Systems Engineering, Scarborough, ME
   4. R.E. Erickson Co. Inc., Walpole, MA
   5. Wilson Controls, Lee, NH
   6. Or equal, having a minimum of 5 years' experience in supplying comparable systems.

1.3 SUBMITTALS TO THE ENGINEER

A. Shop Drawings and Samples:
   1. Submit Shop Drawings and O&Ms in accordance with General Conditions Section 01340 and as indicated herein.
   2. Shop Drawings shall consist of:
      a. Project name and location
      b. Contractor's name
      c. Index Sheet - Listing the equipment being submitted utilizing equipment designations, or symbols, indicated on the Contract Documents together with the proposed manufacturer, style/type and catalog number. The .pdf shall also have integral bookmarks.
      d. Manufacturer's scale or dimensioned drawings along with standard catalog number.
      e. Equipment ratings, service clearances and configuration.
      f. Listing of accessories to be furnished
      g. Panel wiring diagrams showing the location of each mounted component, front panel elevation(s), internal wiring diagram of each component including terminal numbers.
      h. Bill-of-Material Table showing a complete listing of the components in each control panel. Table shall include separate columns for the following: Item Number, Quantity, Manufacturer, Part number, Description, Designator Tag, Supplier name and phone number.
      i. SAT Report:
         i. The SI shall furnish an I/O checkout sheet identifying and acknowledging that field wiring is properly terminated to the SI furnished hardware.
         ii. The SI shall furnish a checklist of all the instruments that have been configured and ready for additional testing.
         iii. The AESS shall furnish a checklist of all of the PLC, SCADA, network, and security functions that have been tested.
      j. SCADA screens, OIT screens, and database tags.
      k. Refer to the other Division 13 Sections for additional shop requirements.
   3. All material shall be contained in one submission; partial submissions will not be accepted.
   4. Submissions shall be in the form and quantity indicated in the General Conditions. Each equipment type shall be separated by index tabs with typewritten titles.
   5. Provide samples of programs, graphics, etc., within 10 days upon receipt of request from the Engineer.

B. Maintain properly documented and witnessed test and checkout reports and submit these to the Engineer. No form of energy shall be applied to any part of the instrumentation system prior to receipt by the Engineer, from the Contractor, of the supplier's certified statement of approval of the installation and containing his authorization to energize the system, except that the supplier's serviceman may do so for the purpose of check-out as described herein.

1.4 DELIVERY, STORAGE AND HANDLING

A. Coordinate material and equipment delivery with the project schedule. Notify the Engineer immediately, in writing, if material or equipment delivery will adversely affect the project schedule, include documentation from equipment suppliers indicating the revised delivery dates and the reason for the delay.

B. Coordinate delivery of equipment directly to other vendors where instrumentation supplied under this section has to be installed in panels supplied under other specification sections.

C. Exercise care during loading, transporting, unloading and handling of materials to prevent damage.

D. Check for defective or damaged materials, and for incomplete equipment shipments within seven days after equipment delivery to the project site.

E. Store materials and equipment on the construction site in enclosures or under protective covering in order to assure that materials and equipment are kept undamaged, clean and dry. The Contractor shall maintain an inventory of instruments and control panels received on site and store in a safe, secure, dry and temperature controlled location. This inventory shall be made available to the Engineer upon request.

F. Replace or repair, to the satisfaction of the Engineer, all materials and equipment that are defective or that have been damaged during installation, at no additional cost to the Owner.

1.5 O&M REQUIREMENTS:

A. Provide the Owner with a list of local service departments of duly authorized distributors of materials and equipment of the type installed, which will stock the manufacturer's standard parts, etc. The list may be included on the bill-of-materials.

B. At the completion of the installation, provide Record Drawings on sheets no less than 11" x 17", indicating the final configuration of all systems as they were installed. Symbols, equipment designations, instrument ISA designations, etc., shall be consistent with the Contract Documents. Provide exact locations of all work which has been concealed in concrete, masonry or underground. The following diagrams shall be included:

1. Control Panel diagrams on 11" by 17" sheet showing the front face and panel mounted equipment with full listing of components including names, descriptions and model numbers for each component. One copy of the panel diagrams will be laminated for insertion into the pocket inside each control panel.
2. Point to Point terminal wiring diagrams for all field instruments, motor starters, equipment drives, valve actuators and other field equipment connected to the control system. When called out provide diagrams meeting ISA S5.4 standards requirements for loop diagrams on 8½" by 11" sheets, showing one loop per sheet. Drawings shall reflect as built conditions.
3. Panel wiring diagrams showing the location of each mounted component; front panel elevation(s) and name plates; internal wiring diagram of each component including field instruments and terminal numbers; and network communications including all provided equipment, on 11” by 17” sheets.

4. Network diagrams on 11” x 17” format. Refer to Section 13444 for additional requirements.
5. Provide a hardcopy set of applicable drawings in each control panel and one binder with a hardcopy of all record drawings.
6. Provide a copy of all record drawings to the Owner and Engineer in AutoCAD DWG format or Adobe PDF format on a USB drive. .pdfs shall have integral bookmarks denoting all sections and subsections. USB drive shall be clearly labeled.

C. Refer to the other Division 13 Sections for additional O&M requirements.

D. O&M Manual Organization:
1. O&Ms shall be organized to be easily navigable. Devices shall be arranged by group and type. Example, all flow meters will be grouped together and arranged so that mag meters are together, than thermal mass meters, etc.
2. The hardcopy operations and maintenance manuals shall be organized in three ring binders with a maximum size of 4". The following is a proposed outline for the O&M Manual(s), provide applicable Sections:

TITLE
Table of Contents
Section 1 - Reserved for description of system by Owner
Section 2 - Field Instruments (arranged by device group and type, ex. Flow meters, submersible level, floats, etc.)
2.1 ISA instrument calibration data sheets and instrumentation listing with part numbers
2.2 O&M literature for each type of instrument with labeled dividers
2.3 Instrument configuration data
Section 3 - Panel Equipment (arranged device type)
3.1 Bill-of-Material Table
3.2 O&M and Manufacturer's literature
Section 4 - Miscellaneous devices (arranged alphabetically by manufacturer)
4.1 Bill-of-Material Table
4.2 O&M and Manufacturer's literature
Section 5 - Drawings
5.1 Network drawings
5.2 Panel fabrication and assembly drawings
5.3 Panel wiring diagrams
5.4 Interconnection wiring diagrams
Section 6 - PLC
6.1 CPU, memory capacity, communication ports
6.2 Rack Layout and module configuration
6.3 I/O List
6.4 PLC communication parameters/ port configuration
Section 7 - Miscellaneous Data
7.1 Data Networking Equipment List
7.2 Data Networking Equipment Configuration, IP Addresses, Layout, and Security Access.

Section 8 - Program (Reserve for AESS)

8.1 PLC Program in native format with data tag registers, cross reference list, and comments.

8.2 OIT programs in native format with screen color Printouts, communication configuration, and data tag printout.

8.3 SCADA programs with screen color printouts, communication configuration, and data tag printout.

8.4 Custom Report Printouts

8.5 Alarm Configuration and alarm tag printouts.

E. The cover and edge of each volume shall contain the following information:

Project Name
Owner's Name

Instrumentation and Control System
Operations and Maintenance Manual
Specification Section 13###
Volume X of Y
(where X is the volume number and Y is the number of volumes)
Subcontractor Name, Date

F. Electronic O&M Information:
1. Supply all electronic files on 4.8 GB DVD-R media or USB drive
   a. .PDFs shall be bookmarked by order of O&M.
   b. Scanned .PDFs shall not be accepted.
2. Refer to other Division 13 specifications for additional information.

G. Warranty Documentation: The Contractor and System Integrator shall investigate, diagnose, repair, update and distribute all pertaining documentation of deficiencies which become evident during the warranty period. All such documentation shall be submitted to the Engineer within 30 days of solving the problem.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:
1. All of the equipment shall be the manufacturer's latest proven design. If a piece of equipment was sole sourced, but is no longer the current version, the SI shall propose and carry the latest version of the product migration path. Specifications and Drawings call attention to certain features, but do not purport to cover all details entering into the design of the instrumentation and process control system. The completed system and the equipment furnished by the Contractor shall be compatible with the functions required.
2. Components shall be finished to the manufacturer's standard for the service intended unless otherwise indicated in the Specifications or on the Drawings.

3. All electrical components of the system shall operate on 120-volt, single-phase, 60-Hertz current, except as otherwise noted in the specifications and drawings. Power shall be supplied from either local electrical distribution panels, or an associated control panel UPS with breakers for each circuit as indicated on the Instrumentation and Electrical drawings.
4. All controls for electrically operated or motor-driven equipment (including electrically actuated valves, small pumps and chemical feed equipment, etc.) shall be complete, including all necessary auxiliary relays, so as to require only wiring and connections to the equipment control circuit. All contacts for control of motor-operated or electrically operated equipment shall be rated not less than 10 amperes on 120 volts unless otherwise specified herein.
5. Panel components including switches, relays, instrumentation, etc. supplied by the various process equipment manufacturers, but indicated to be installed within panels furnished by the System Integrator, shall be furnished to the System Integrator for incorporation into his panels. Equipment shall be installed to the manufacturer's requirements and recommendations. System Integrator shall install these items within his panel and shall produce a complete, functional, pre-wired system for installation requiring only external power and instrumentation connections. The Contractor shall coordinate this requirement and shall ensure that equipment manufacturers provide all necessary installation instructions and requirements to the System Integrator.
6. Identification:
    a. All panels, and control devices shall have identifying nameplates. Equal quality nameplates shall be attached to all field-installed units.
    b. Each field transmitter shall have an attached manufacturer's tag with the Manufacturer's name, model number, serial number, power requirements, and scaled range of the instrument.
    c. Provide suitable lamicoid labels for each process measurement element and transmitter. Label will identify each medium being measured, range and units of measurement and indicating transmitter/element ID No., for example:

Wetwell Level Transducer
0.0 to 23.1 ft
LE/LT-205

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. The Specifications and Drawings do not attempt to fully indicate the degree of assembly, subassembly, shipped condition, extent of field work, or degree of accuracy required to install the equipment or materials. The Contractor shall be required to rely on his prior experience or to otherwise inform himself of the amount of field work required to assemble, erect, and install the equipment or

material, as received, to produce a finished installation ready for use or operation.

2. All equipment installed as part of the work shall be positioned, assembled, aligned, doweled, and otherwise set to the tolerances required by the equipment manufacturer. Where tolerances and methods are not specifically indicated, they shall be in accordance with best millwright practice.
3. All materials incorporated in the work shall be installed in accordance with the Drawings and Specifications. Where detailed drawings or technical specifications are not provided, the materials shall be installed in accordance with the manufacturer's preferred recommendations and conforming to the best practice of the trade involved. Installation shall include all accessories required to produce a completed installation ready for use.
4. The Owner will assume no liability or responsibility for any portions of the installation under this Contract until they are demonstrated and accepted in writing. Final demonstrations shall be made only after the Owner and Engineer are satisfied that the work has been completed in accordance with the intent of the Contract Documents.
5. Sensors or instrumentation to be installed shall be provided with sufficient cable length and mounting configuration for easy removal, service, and replacement. The service of the instrument shall not require its wiring removed or disconnected. Any instrument found deficient in this area shall be reconfigured by the Contractor as approved by the Engineer at no additional cost to the Owner or Engineer. Refer to instrumentation details or submit an RFI prior to procurement, submittal, and/or installation.

B. Electrical Work:
   1. All electrical work shall conform to the requirements indicated in Division 16.

C. Procedures Prior to Startup:
   1. The Contractor and System Integrator shall:
      a. Coordinate and schedule the work of the AESS service personnel through Engineer as necessary. The AESS shall be onsite during VFD and MCC startup and configuration to verify proper connection and scaling to the control panel using PLC program.
      b. All wiring will be installed, terminated, and tested by the Contractor in each control panel. Wire labeling shall be coordinated between the SI and the Electrical Contractor during construction to assign terminal numbers in loop drawings of all field terminations, including intermediate junction boxes. Refer to Section 16010.
      c. Calibrate and configure all Division 13 supplied instrumentation as specified in Section 13440.
         i. Verify that each instrument is properly installed, configured, and is properly measuring values for the application.
         ii. Coordinate with the AESS that the control system is scaling matches the instrument scaling.
         iii. Provide digital averaging/filtering or any other advanced configuration where required for proper equipment control. This “filtered” engineering process signal used for process control shall

accurately track and represent the original engineering process signal without “turbulence”, “signal delay” or “signal droop”.

iv. Configure all instruments to fail in the safest condition for the specific application. Example, a wastewater pump station with backup floats should have the analog level measurement fail low and a water plant finish water chlorine instrument should fail to a value to shut the facility down.

d. Verify the facility installation.

e. Be onsite during Equipment Startup to verify equipment wiring and basic functionality of Division 13 furnished equipment.

f. Coordinate and verify interface with electrical equipment, including field wiring terminations.

g. Document hardware configuration and wiring information.

h. Configure all furnished network equipment unless otherwise specified.

i. Demonstrate network functionality.

2. The Contractor and AESS shall:

a. Prior to the witnessed site acceptance testing, the AESS shall perform a preliminary test to verify operation prior to witnessed testing. The Contractor shall assist as necessary.

b. Perform and IO checkout from field device to PLC prior to any automated and PLC testing.

i. The AESS shall monitor and manipulate the PLC inputs and outputs through the PLC program.

ii. The Contractor, Electrical Contractor, and SI will assist with testing IO from devices. The individual(s) assisting with checkout shall be qualified to do the required testing.

c. Coordinate VFD interface and scaling.

3. The Contractor, System Integrator, and Owner shall coordinate the installation of the telemetry system during startup.

D. Site Acceptance Testing

1. A Site Acceptance Test shall be performed on each Division 13 control system after the installation at each site to verify that each instrument and equipment drive is connected properly to the control panel and that all functions of the control panel are operating as specified.

a. The Contractor shall schedule Startup and SAT activities with the Engineer at least 5 business day in advance.

b. The Contractor shall not schedule more than 3 days of site acceptance testing, or training during any week without agreement from the Engineer and Owner. No site acceptance testing shall occur on Fridays without agreement from the Engineer and Owner.

c. Additional SAT activities restrictions may be determined by the Owner.

2. The Contractor and SI shall:

a. Verify the facility installation.

b. Demonstrate proper instrument configuration.

c. Provide final instrument field calibration sheet/documentation after SAT has been completed.

d. Verify accuracy of documentation, operator's manuals, software documentation, and site operating instructions, etc. after SAT has been completed. Documentation shall include all field modifications.
e. Troubleshoot and correct any hardware deficiencies, including, but not exclusive to communications issues identified by the AESS that are not due to the configuration of the device.
f. Be available during the Site Acceptance Test to correct any hardware deficiencies and/or adjust instrument configurations as necessary.

3. The Contractor and AESS shall:
   a. The AESS will be responsible for all PLC, OIT, and SCADA programming. The Contractor will be responsible for all hardware and equipment unless otherwise specifically stated.
   b. Demonstrate each functional requirement identified by the Specification.
   c. Demonstrate all equipment control functions, including the operation of automatic control strategies. Actuation of field devices and operation of equipment shall be closely coordinated with Engineer and Owner's staff.
   d. Demonstrate all networking functionalities.
   e. Verify system performance parameters and system responses under field operational conditions.
   f. Demonstrate all equipment control functions, including the operation of automatic control strategies. Actuation of field devices and operation of equipment shall be closely coordinated with Engineer and Owner's staff.
   g. Provide digital averaging/filtering or any other advanced configuration where required for proper equipment control.
   h. Verify system performance parameters and system responses under field operational conditions.
   i. Verify accuracy of documentation, especially operator's manuals, software documentation, and site operating instructions. Documentation shall include all field modifications.
   j. Provide completed site acceptance testing (SAT) test documentation. Including:
      i. Startup reports
      ii. Initial startup values
4. The SAT will be observed by the Engineer and/or Owner's representative.

E. Refer to Section 01800 for additional startup, testing, training requirements for the instrumentation equipment.

END OF SECTION

SECTION 13440

INSTRUMENTATION AND PROCESS CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:

1. Field Instruments:
   a. Furnish and install the instrumentation as shown on the Drawings and listed in the Instrumentation Schedule at the end of this Section. The locations of the instruments are shown on the Process and Electrical Drawings.
   b. Instruments shall be installed in accordance with the Drawings and as indicated in the Manufacturer's installation manuals. Any deviation in instrumentation or electrical installation requirements for the supplied equipment shall be provided at no additional cost to the Owner.
   c. Provide support as necessary during Site Acceptance Testing to adjust the configuration of field instruments (E.g. signal dampening, ranges, echo suppression, etc.).
   d. Provide ISA sheets and instrument configuration documentation after acceptance testing.
2. Miscellaneous:
   a. Furnish and install all transducers, media converters, protocol converters, terminals, transformers, interposing or pilot relays (for both new and existing equipment), signal transmitters, signal splitters/boosters, intrinsic safety barriers, power supplies, power supply connections and other miscellaneous instrumentation required to make a complete system.
   b. Furnish and install all vendor or manufacturer cables and appurtenances between primary instruments and the transmitters, receiving instruments or destination terminals with sufficient service loop. Manufacturer cables between elements and transmitters shall not be spliced without prior engineer approval. All methods, materials and supplies will meet the requirements of Division 16.
   c. Furnish mounting hardware for each instrument. The System Integrator will provide information on the proper installation in accordance with the Manufacturer's requirements for each instrument and shall supervise the installation. Tubing, process taps and an isolation valve will be provided under Mechanical in Division 11 and 15 unless otherwise specified. Coordinate the size and type of connection required. Refer to the Instrument Installation Detail Drawing in the Contract.
3. Acceptance Testing:
   a. Refer to Section 13410 for additional requirements.
   b. O&M Documentation:

i. Provide complete O&M documentation as listed in Specification 13410, including:
   (1) Final ISA S20 instrument data sheets (or equivalent) with updated calibration data. The ISA instrument datasheet shall be representative of the latest version. If the calibration and configuration data is on the instrument configuration sheets, the calibration and configuration data does not need to be replicated.
   (2) Instrument configuration sheets (often seen in the appendixes of the instrument manuals). Configuration sheets shall be completed with all non-default values.

4. Coordination:
   b. Provide manufacturer recommended installation and mounting requirements for each instrument to be connected to process equipment, piping or fittings requiring a process connection such as NPT taps, sample piping and process line insertion. The System Integrator will supervise and provide guidance on proper installation of instrumentation equipment. This shall include manufacturer's recommended mounting installation requirements (clearances for level sensors per manufacturer's blanking distance, etc.) Refer to the execution requirements below for additional installation requirements.
   c. The System Integrator shall coordinate and provide calibrated instrument ranges to the AESS for scaling and programming purpose.

C. Related Work Specified Elsewhere:

Section	Title
13410	Instrumentation and Control General
13441	Control Loop Descriptions
13444	Control Panels

1.2 QUALITY ASSURANCE

A. Materials and equipment furnished under this Contract shall be standard products of manufacturers regularly engaged in manufacture of such products and shall be manufacturer's latest standard design that complies with Specification requirements. Products shall essentially duplicate material and equipment that have been in satisfactory local use at least three years.

1.3 SUBMITTALS TO THE ENGINEER

A. Shop Drawings and Samples:
   1. Submit Shop Drawings and O&Ms in accordance with General Conditions Section 01340, 13410, and as indicated herein.
      a. Manufacturer's scale or dimensioned drawings along with standard catalog number. Catalog number shall be written on any cutsheet that has an extensive part number or highlighted.
      b. Equipment ratings, service clearances and configuration.
      c. Listing of accessories to be furnished

d. ISA Instrument Sheets (or equivalent)

2. All material shall be contained in one submission; partial submissions will not be accepted.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:

1. Refer to Section 13410.

B. Instrumentation Equipment (Refer to Instrumentation Schedule at the end of this Section)

1. **Submersible Level Transducer and Transmitter: LE/LT**

a. Provide submersible pressure transducers, as indicated in the Instrumentation Schedule, with the following requirements.

b. Transmitter:

i. Type: Submersible with Integral Pressure Measuring Element
ii. Power: 24 VDC Loop Power
iii. Accuracy: 0.25% full span
iv. Analog Output: 4 to 20 mA DC
v. Enclosure Rating: NEMA 6P
vi. Communications Protocol: None
vii. Measuring Range: Per Instrumentation Schedule

c. Measuring Element:

i. Type: Submersible Elastomeric Diaphragm Pressure Sensor
ii. Applications:
(1) Pretreated Waste Water
iii. Materials:
(1) Housing: Stainless Steel or PVC
(2) Diaphragm: Teflon
(3) Cable: Teflon or Polyurethane
(4) Cable Gland: Viton
(5) Measuring Cell Fluid Fill: Silicone Oil
iv. Diaphragm: Minimum 0.89" diameter non clogging
v. Operating Temperature: 32 to 122 °F (compensated over entire temperature range)
vi. Burst Pressure: 2X Full Span
vii. Atmospheric Pressure Reference: Atmospheric reference tube with aneroid bellows breather system.
viii. Lightning Protection: Full Lightning Protection

d. Accessories and Spare Parts:

i. Provide a stainless steel mounting rack with an adjustable cable stop for each submersible pressure transducer. Refer to mounting details.

e. Process fluid shall directly act on the outer diaphragm. The pressure from the process fluid shall be transmitted to the pressure measuring element by the silicone oil fill fluid.
f. Connect transducer signal wires to a terminal strip in a Division 16 provided junction box. Provide a minimum of 2' of service loop of signal cable from the instrument. Bellows type vent tube will shall also be terminated in the junction box.
g. Transducers that are mounted in a Class I, Div. 1/2 designated areas shall be intrinsically safe and be protected by a suitable intrinsically safe barrier. Refer to Instrumentation Schedule for hazardous area requirements.
h. Mounting
    i. Provide a 12-inch long section of 316 stainless steel pipe, ¾ to 1-inch diameter with NPT threads to mount to the transducer. The transducer and pipe shall be suspended using a stainless steel PVC coated cable with stainless steel clamps and bolts with friction nuts. Refer to details.
    ii. Submersible pressure transducers that are 2-inch in diameter or smaller shall be installed in a stilling well. Stilling well shall be constructed of 3-4" PVC and suspended from the wall of the wetwell by stainless steel pipe clamps.
    iii. The measuring face of the field instrument shall be located approximately 6" above the tank finished floor.
    iv. Install aneroid bellows in Division 16 supplied junction box.
i. Equivalent to:
    i. KPSI Model 705
    ii. Siemens Model A1000i
    iii. Contegra Model SLX130
    iv. Or equal

2. **Float Type Level Switches (for Intrinsically Safe circuits): LSLL, LSL, LSH, LSHH**
    a. Provide a float switch, as indicated in the Instrumentation Schedule, with the following requirements. A non-mercury float switch shall be provided with non-oxidizing contacts to allow low DC voltage signals for use with intrinsic safety devices.
    b. Float Switch
        i. Type: Narrow angle float switch
        ii. Applications:
            (1) Raw Wastewater
        iii. Materials: Polypropylene float
        iv. Operating Temperature: 32 to 140 °F
        v. Float Rating: Submersible
        vi. Cable: 18 AWG

vii. Switch Contacts: SPDT

c. Accessories and Spare Parts:
   i. Provide a stainless-steel mounting rack with an adjustable cable stop for each float switch.
   ii. External weight set for setting float switch activation angle

d. Class I, Div. 1/2 Installations:
   i. Float switches that are mounted in a Class I, Div. 1/2 designated areas shall be intrinsically safe and be protected by a suitable intrinsically safe barrier.
   ii. Float switch cables will terminate in a junction box rated for Class I, Div. 1/2 areas as required by the installation. The gas tight seal, required when transitioning between hazardous and non-hazardous areas, will be installed after the junction box. The manufactured cable will be spliced in the junction box and extend to the respective control panel.

e. Refer to Instrumentation Schedule for hazardous area requirements. Equivalent to:
   i. SJE Rhombus MegaMaster Control Switch (PN 1046501)
   ii. No equal

3. **Float Type Level Switches (for Intrinsically Safe circuits): LSLL, LSL, LSH, LSHH**

a. Provide a differential float switch, as indicated in the Instrumentation Schedule, with the following requirements.

b. Float Switch
   i. Type: Wide angle float switch
   ii. Applications:
      (1) Raw Wastewater
   iii. Materials: PVC
   iv. Operating Temperature: 32 to 140 °F
   v. Float Rating: Submersible
   vi. Cable Length: 60 feet
   vii. Maximum Differential Band: 60 feet
   viii. Switch Contacts: SPDT

c. Accessories and Spare Parts:
   i. Provide a stainless-steel mounting rack with an adjustable cable stop for each float switch.
   ii. External weight set for setting float switch activation angle.
      (1) Float is used for backup pump control. Float shall have a one foot swing such that the backup pump on elevation is 18.41 and the backup pump off elevation is 17.41.

d. Class I, Div. 1/2 Installations:
   i. Float switches that are mounted in a Class I, Div. 1/2 designated areas shall be intrinsically safe and be protected by a suitable

intrinsically safe barrier.

ii. Float switch cables will terminate in a junction box rated for Class I, Div. 1/2 areas as required by the installation. The gas tight seal, required when transitioning between hazardous and non-hazardous areas, will be installed after the junction box. The manufactured cable will be spliced in the junction box and extend to the respective control panel.

e. Refer to Instrumentation Schedule for hazardous area requirements. Equivalent to:
   i. Magnetrol Model T10 (PN T10-5104-060)
   ii. No equal

4. **Temperature Element, Indicator with Switch: TSL, TSH**
   a. Provide temperature switch, as indicated in the Instrumentation Schedule, with the following requirements.
   b. Temperature Switch:
      i. Type: Dual point temperature switch with thermistor type sensor. Sensor and relay shall be provided by the same manufacturer and shall be matched to make a function instrument system.
      ii. Applications:
         (1) Air
      iii. Display: LCD
      iv. Power: 120 VAC
      v. Analog Output: None
      vi. Enclosure Materials: Thermoplastic
      vii. Switch Contacts:
         (1) NO
         (2) NC
         (3) 10 amps at 120 VAC
      viii. Setpoint Adjustment: Programmable through onboard keypad
      ix. Operating Temperature: 32 to 122 ºF
      x. Enclosure Rating: NEMA 4X
      xi. Electrical Connections: ½" NPT
      xii. Memory: Non-volatile
      xiii. Mounting: Wall Mountable
   c. Accessories and Spare Parts:
      i. None
   d. Equivalent to:
      i. Ranco
      ii. Honeywell
      iii. Johnson Controls
      iv. Or equal

5. **Magnetic Flow Meters and Indicating Transmitters: FE/FIT**

a. Provide electromagnetic type flow meters, as indicated in the Instrumentation Schedule, with the following requirements.
b. Transmitter:
   i. Type: Remote Panel Mount
   ii. Display: Backlit LCD
   iii. Power: 120 VAC
   iv. Accuracy: Minimum 0.50% of rate above 1 ft/s fluid velocity
   v. Analog Output: 4 to 20 mA DC
   vi. Discrete Output: Sinking 24 VDC Pulse
   vii. Operating Temperature: -4 to 120 ºF
   viii. Electrical Connections: ½" NPT
   ix. Enclosure Rating: NEMA 4X
   x. Communications Protocol: None
   xi. Memory: Non-volatile
   xii. Measuring Range: Per Instrumentation Schedule
c. Measuring Element:
   i. Type: Flange Style flow tube for continuous flow measurement
   ii. Applications:
      (1) Pretreated Wastewater
   iii. Materials:
      (1) Housing & Flanges: Carbon Steel with painted corrosion resistant coating
      (2) Measuring tube: 304 Stainless Steel
      (3) Liner: Hard Rubber
      (4) Measuring Electrodes: Hastelloy C
   iv. Ground Reference: Stainless Steel Ground Rings
   v. Operating Temperature: -30 to 150 °F
   vi. Operating Pressure: Max 230 psi
   vii. Electrical Connection: ½" NPT
   viii. Process Connection: ANSI B16.5 Class 150 connections compatible with the type and classification of pipe installed.
   ix. Size: Per Instrumentation Schedule
   x. Enclosure Rating: Per Instrumentation Schedule
d. Accessories and Spare Parts:
   i. Grounding electrodes.
e. For Flow Tubes mounted in Class I, Div. 1/2 area the entire flow meter system shall be rated for that classification and carry the required Factory Mutual approval. Refer to Instrumentation Schedule for required flow tube enclosure rating.
f. The PLC shall use a counting function, in conjunction with the transmitter pulse output, to totalize flow through the flow meter. The pulse output shall close the circuit each time a configurable volume passes through the flow tube. The pulse output shall be configurable through the flow meter transmitter.

g. Equivalent to:
   i. Siemens Sitrans Mag 5000 with 5100 flow tube
   ii. Khrohne IFC 100 with Optiflux 2000 series flow tube
   iii. Rosemount 8712E with 8750W series flow tube
   iv. Or Equal

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
   1. The Specifications and Drawings do not attempt to fully indicate the degree of assembly, subassembly, shipped condition, extent of field work, or degree of accuracy required to install the equipment or materials. The Contractor shall be required to rely on their prior experience or to otherwise inform himself of the amount of field work required to assemble, erect, and install the equipment or material, as received, to produce a finished installation ready for use or operation.
   2. All equipment installed as part of the work shall be positioned, assembled, aligned, doweled, and otherwise set to the tolerances required by the equipment manufacturer. Where tolerances and methods are not specifically indicated, they shall be in accordance with best millwright practice.
   3. All materials incorporated in the work shall be installed in accordance with the Drawings and Specifications. Where detailed drawings or technical specifications are not provided, the materials shall be installed in accordance with the manufacturer's preferred recommendations and conforming to the best practice of the trade involved. Installation shall include all accessories required to produce a completed installation ready for use.
   4. Sensors or instrumentation to be installed shall be provided with sufficient cable length and mounting configuration for easy removal, service, and replacement. Access to the instrument shall not require its wiring removed or disconnected. Any instrument found deficient in this area shall be reconfigured by the Contractor as approved by the Engineer at no additional cost to the Owner or Engineer. Refer to installation details. Coordinate with Engineer, Electrical Contractor, and General Contractor as required.

B. Electrical Work:
   1. All electrical work shall conform to the requirements indicated in Division 16.

C. Field Calibration:
   1. All instrumentation shall be calibrated in the presence of the Owner and Engineer using manufacturer's recommended calibration procedure and standards.
   2. All flow and level transmitters shall be factory calibrated and set up to the extent possible at the factory. Span, range, and operating parameter adjustment shall be made at the factory or in the field by a factory trained personnel. Each system shall meet the manufacturer's standard accuracy.

3. Analyzing instruments shall be field calibrated by a factory-trained engineer or technician using procedures recommended by the manufacturer. Provide all materials required for proper calibration. Calibration shall be done in the presence of the Engineer.
4. Secondary functions such as alarm actuations and pacing shall be adjusted during initial calibration and demonstrated after the system is placed in service. Range adjustments shall be sealed by colored lacquer in the presence of the Engineer immediately following calibration.
5. Process calibration, such as volumetric drawdown tests on flows and level measurements, shall be conducted on all measuring systems as requested by the Engineer.
6. Provide instrument calibration sheet if factory calibrated (per the scaled range in the instrumentation schedule) by the instrument manufacturer.
7. Each instrument will be provided with an adhesive sticker declaring the date of certified calibration and initialed by the factory authorized field personnel.
8. Update any instrument configuration documentation after acceptance testing.
9. Refer to Specification 01800 and 13410 for startup, testing, training requirements for the instrumentation equipment.

INSTRUMENTATION SCHEDULE

TAG	TYPE/SIZE	DESCRIPTION	LOCATION	RANGE	UNITS	SERVICE	POWER	P&ID	SPEC. SECTION
LE/LT-205	SUB	Wet Well Level Element and Transmitter	Wet Well	0.0 to 10.0 0.0 to 23.1	psi ft	NEMA 6P C1D1	120VAC	I-2	13440 2.1.B.1
LSLL-205	FLT	Wet Well Low-Low Level Float Switch	Wet Well	-	-	NEMA 6P C1D1	-	I-2	13440 2.1.B.2
LSHH-205A	FLT	Wet Well High-High Level Float Switch	Wet Well	-	-	NEMA 6P C1D1	-	I-2	13440 2.1.B.2
LSHH-205B	FLT	Wet Well Backup Control Float Switch	Wet Well	-	-	NEMA 6P C1D1	-	I-2	13440 2.1.B.3
FE-215 FIT-215	4” MAG	Raw Sewage Flow Meter and Indicating Transmitter	Element: Valve Vault Transmitter: MCP	0.0 to 250.0	GPM	Element: NEMA 4X C1D2 Transmitter: NEMA 4X	120 VAC	I-2	13440 2.1.B.5
TSL-225 TSH-225	TEMP	Control Panel High and Low Temperature Switches	MCP	32.0 to 122.0	Deg F	NEMA 12	120 VAC	I-2	13440 2.1.B.4

FLT - Float SUB - Submersible TEMP - Temperature MAG - Electromagnetic

END OF SECTION

SECTION 13441

CONTROL LOOP DESCRIPTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes control descriptions for loop diagrams shown on the Instrumentation Drawings.

B. Control Loops Descriptions shall be used by the Application Engineering Services Supplier (AESS) for developing PLC code and SCADA development under this contract. The AESS or SI executing this specification shall be referred to as the "programmer" herein.

C. The General Contractor shall coordinate with the AESS and System Integrator to maintain project schedule.

1. Equipment startup shall be completed at least two weeks before substantial completion.
2. Site Acceptance Testing shall be started no later than 4 weeks prior to substantial completion.

D. The Programmer shall be responsible for all of the scope within this specification unless specifically stated otherwise.

E. At a minimum, all status, alarm, and control signals shown on the drawings shall be provided as such and in accordance with the CONTROL DESCRIPTIONS - GENERAL unless specifically stated otherwise.

F. The specific requirements of the custom software will be defined during the Shop Drawing submittal process, with the input of the Owner and Engineer. A meeting(s) will be held at the project site, with a representative of the System Integrator, PLC Programmer/Supplier, Client, Contractor, and Engineer, to finalize the custom programming specifications.

G. The Programmer shall provide 8 hours of additional programming time and 1 round trip to be used for scope not listed. Unused programming time in the first year will be given to the Owner as a credit.

H. AESS:

1. Control Loops Descriptions shall be used by the Application Engineering Services Supplier (AESS) for developing PLC code and SCADA development under a separate Contract with the Owner.
2. The specification is provided for the Contractor's information with regard to the scope of the programming and the level of coordination that the System Integrator and General Contractor shall include in the Contractor's Bid.
    a. The AESS shall coordinate with the General Contractor and System Integrator, refer to Section 13410 for factory acceptance and site acceptance testing roles.
    b. The AESS shall keep the existing format of the SCADA screens to the greatest extent possible when modifying the controls interface.

c. The AESS Provide an O&M as outlined in Section 13410 with annotated ladder logic as outlined in Section 13444.

3. The Programmer shall update and create the SCADA Screens and alarms for the new functionality as described herein. The AESS shall update SCADA computers at the WWTP.
4. The Programmer shall provide 8 hours to update the existing reports for the WWTP.
5. The Programmer shall assign IP addresses and establish communication to all network Division 11 panels, VFD's and other networked equipment outside of Division 11 manufacturers
6. The specific requirements of the custom software shall be defined during the Shop Drawing submittal process, with the input of the Owner and Engineer. A meeting shall be held at the project site, with a representative of the Programmer, Client, Contractor, and Engineer, to finalize the custom programming specifications.

1.2 SYSTEM DESCRIPTION

A. Provide instrumentation hardware, software and programming as necessary to perform control functions specified herein and as shown on drawings. Ensure coordination with other work to ensure that necessary wiring, conduits, contacts, relays, converters, and incidentals are provided in order to transmit, receive, and control necessary signals to other control elements, to control panels, and to receiving stations.

B. The specifications direct attention to certain required features of the system, but do not purport to cover all details entering into its design and construction. Nevertheless, the Contractor shall furnish the CONTROL LOOPS complete in all details and ready for operation.

1.3 SUBMITTALS

A. Shops
   1. Provide annotated versions of the PLC, operator interface terminal and SCADA programming files in .pdf format for review by the Engineer. Provide the PLC and OIT files 15 days prior to FAT.

B. Operation and Maintenance Manuals:
   1. Provide annotated final versions of the modified PLC, operator interface terminal and SCADA programming files on DVD or USB drive. The PLC and OIT programing files shall be stored on individual USB drives located in each of the respective control panels as well as a USB drive with the SCADA programming files.
   2. Refer to Section 13410 for additional O&M sections.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 CONTROL DESCRIPTIONS – GENERAL

A. Operator Interface Terminal (OIT) and SCADA software will be used for process monitoring and control as noted in the specific control loop descriptions. OIT and SCADA screens shall be constructed in accordance with the following general requirements:

1. Process Overview Screen showing status and location of each process related field instrument and process equipment in relation to the Process Flow Diagrams (PFD) and Process and Instrumentation Diagrams (P&ID). Operators shall be able to access more detailed screens for equipment control, process control setpoints and time delays, mode control, alarm history, and alarm setpoints and time delays.
2. Process Equipment Control Screens: Screens and pop-up displays shall be provided for process equipment monitoring, equipment control, and operating parameters/setpoints and delay timer adjustment.
3. Alarm Summary and Alarm Set-up Screens: Screens shall be provided to display active alarms, entry of alarm setpoint values and delay timer settings, and enable/disable alarms. The screens shall also include capability to acknowledge and reset alarms.
4. Graphical symbols shall be used to represent each piece of process equipment and field instrument. Equipment symbols that are used shall be representative of each piece of equipment displayed. Instrument symbols shall be in accordance with ISA S5.1 standards and Instrument Drawing I-1.
    a. Refer to Instrumentation Drawing I-1 “Indicator Light Color Legend” for light color convention.
    b. Display the status and process values for all equipment in the system.
    c. Refer to the Instrument Schedule in Section 13440 for all process value scaling and ranges.
5. Skeuomorphism shall be used as a design theme as required for quickly familiarizing the operator with the functionality.
6. Alarm History Screen: A screen shall be provided to display all active and past alarms. The operator shall also be able to acknowledge and reset alarms from this screen.
7. Provide an alarm banner on each OIT/SCADA screen that displays at a minimum the last three alarm conditions. Active alarms shall flash in red. Acknowledged alarms shall be “solid” red.
8. Process Variable Historical Trends shall include the following:
    a. Screens shall be provided to display historical trends of all process variables with adjustable scale and units.
    b. The operator shall be able to add and delete pens as necessary and load and save pen groups to form analytical groups of data.
    c. Trends shall be configured to minimize space on hard drive by updating on change only.

B. All process, operational and alarm setpoints and associated delay-timer setpoints will be adjustable through the OIT/SCADA screens and will be generated and controlled at each respective PLC.

C. All Control Loop programming shall be done in the PLC where the inputs/outputs terminate unless otherwise stated. All PLC tags shall be descriptive in nature.

D. Equipment Fail Alarms:
   1. Equipment Fail alarms are defined as a condition where a command is given and the status confirmation of that command is not received within an acceptable time-frame. Fail Alarms shall not be triggered in the event of Loss of Power, or any other alarms related to the equipment (ie. High Temp, O/L. Fault, Low Pressure, etc.). Examples are as follows:
      a. Fail to start-stop: A piece of equipment is given the command to start and the running status is not confirmed within an appropriate time delay. Conversely a piece of equipment is commanded to stop and the run status does not drop out within an appropriate time delay.
      b. Fail to make speed: A VFD driven piece of equipment is commanded to go to a specific speed and it does not reach that speed (within a deadband) within an appropriate time delay.
   2. Provide the applicable Equipment Fail alarms for all equipment based on type and I/O available.

E. Where specifically noted in the loop descriptions software Hand/Off/Auto and On/Off selector switches shall be forced to the OFF position under certain interlock logic conditions so that an energized run output from the PLC is de-energized. This will require an operator to manually restart the equipment or to place the equipment in AUTO to allow for automatic operation. The H/O/A selector shall not be enabled in the HAND or AUTO positions until the condition causing the forced placement to the OFF position has returned to normal.

F. In the event of an instrument or process analyzer failing or loss of signal, the PLC shall utilize last know value as not to upset the process condition/control. An alarm shall be generated as “loss of signal” for that particular instrument/analyzer.

G. All SCADA Servers, View Nodes, and PLC’s shall time sync once a day. A single SCADA Server shall time sync with the NIST server. A Firewall exception policy shall be created to allow for the specific address and protocol.

H. Control Loops
   1. Local LOR/HOA – all local hardware selector switches shall:
      a. In Local or Hand position run the associated equipment to be used in conjunction with Open-Stop-Close pushbuttons or a potentiometer for valve position or VFD speed.
      b. In Off position, Stop the associated equipment
      c. In Remote or Auto position, the control of the associated equipment shall be transferred to the PLC. At the OIT/SCADA the operator shall control the equipment with either a software HOA or both a software HOA and an OSC. The OIT/SCADA system will display the “In Remote” and “Not in Remote” status based on an auxiliary contact in the Remote position. This status shall be displayed near the software selector switch. The same shall apply for “Auto” and “E-stop”.
   2. Software HOA – all OIT/SCADA software selector switches shall:
      a. In Hand position Run the associated equipment in manual mode whereby an operator can make adjustments with setpoint speed or position entry.

b. In Off position, Stop the associated equipment from running remotely.
c. In Remote or Auto, the control of the associated equipment shall be transferred to PLC control as described in the control loop.
d. Related alarms such as Motor High Temperature, E-Stop, etc. shall be displayed as statuses at the LOR/HOA controls or with the equipment status.

3. Runtime Hours Totalizing –
   a. All equipment with a Run Status signal shall be configured in the PLC for run hour totalizing with display at OIT/SCADA.
   b. Runtime Hour totals shall be configured as both running totals with a password protected (or higher user privilege) reset and with a separate pushbutton resettable total.
4. Alarms: All alarms shall be displayed and identified as an alarm priority. Alarm priorities shall be indicated as 1 through 4.
   a. 1 – Critical priority
   b. 2 – High priority
   c. 3 – Low priority alarm
   d. 4 – Warning, notice, or informational event
   e. Only Level 1 & 2 alarms shall dial out.
   f. The specification assigns initial alarm prioritization. Owner and engineer reserve the right to change alarm priority at no cost.
   g. All alarms will be able to be enabled or disabled by SCADA users. Refer to the Security Section below.
   h. All alarms shall be latched upon activation and reset with the Alarm Acknowledge pushbutton unless otherwise specified.
   i. All alarms, unlatching and latching shall be logged in the alarm history.
   j. All alarms shall be able to be enabled or disabled with a button.
   k. Delays – Alarms shall activate if TRUE setpoint exceed for this adjustable time period (0-60 seconds, initially 5s).
5. Analog Alarms: shall be configured at the OIT/SCADA with the following (operator adjustable):
   a. Low and High Setpoints as specified in specific loops below
   b. Low Low and High High Setpoints as specified in specific loops below.
6. Digital Alarms: all alarms noted as such or as other (fault, overload, fail, E-Stop, etc.) on drawings as shall be configured at the OIT/SCADA with the following (operator adjustable):
7. Alarm Dialing: Refer to Alarms above.
8. Security: Level 1 alarms will only be able to have the setpoints changed, enabled or disabled by Supervisor account levels or higher.
9. Timer modes: Any control that requires a duration setpoint shall include a countdown displayed value to indicate to the operator the length of time until the mode expires or starts.
10. Totalizer modes: Any control that requires a totalized setpoint shall include a current total displayed value to indicate to the operator the current progress towards the setpoint.

11. PLC Failure Mode: Upon PLC failure, all discrete outputs shall de-energize to an off condition.
12. Mode or equipment selections shall be selected by a description. Selecting a number associated with a selection shall not be acceptable.

I. Logging & Auditing: Provide the necessary programming and configuration to perform the logging specified in Specification 13443.

J. Emergency Standby Power:
1. The System Integrator shall provide programming of time delays to stagger restarting of equipment and loads as sequenced in Section 16620 – Diesel Generators.
2. The adjustment, sequencing, and staging of the loads will be adjustable by Supervisor account levels or higher.

K. Reading/Writing across the Network– Provisions shall be made such that multiple points of access have the ability to change setpoints and modes. This functionality shall be furnished such the setpoint or command will automatically reset and the operator does not have to intervene. The setpoint or command shall change to a value that does not have control in the system once the required change is made.

3.2 CONTROL DESCRIPTIONS – MARJORIE CONTROL PANEL

A. Loop 200 – Marjorie Pump Station Control Panel (MCP)
1. General: Two status lights shall be on the face of the Control Panel to provide an indication of panel status. The PLC generates latching alarms that illuminates an alarm light on the face of the panel. A reset pushbutton on the panel or at the OIT shall unlatch the alarms.
2. Panel Control definitions are defined on the Instrument Drawing I-1.
3. Local Control:
   a. The Normal Power indicating light shall be illuminated and a power fail relay shall be energized when the control panel is powered from an external 120 VAC power circuit.
   b. When power from the external 120 VAC circuit is lost and the control panel is powered by the UPS, the power fail relay shall de-energize, the Normal Power indicating light shall not be illuminated.
4. PLC:
   a. The PLC shall monitor the power failure contact and shall activate the Marjorie Control Panel Power Fail alarm if an adjustable on-delay timer expires (0 to 600 seconds, initially 60 seconds).
   b. The PLC shall output a common alarm if any of the alarms configured in the PLC program are active. This common alarm output shall activate the Common Alarm indicating light on the panel.
   c. The contact state of the reset pushbutton shall be monitored by the PLC. When pushed, the PLC shall unlatch the Common Alarm if the alarm condition has returned to normal.
   d. The PLC shall activate a Marjorie Control Panel Surge Alarm when the Surge contact activates (delay 0-600s, initially 1s).
   e. The PLC shall activate a Marjorie Control Panel UPS Fail Alarm when the ATR contact activates (delay 0-600s, initially 5s).

5. Alarms at OIT/SCADA:
    a. Marjorie Pump Station Control Panel Power Fail Alarm
    b. Marjorie Pump Station Control Panel Common Alarm
    c. Marjorie Pump Station Control Panel UPS Fail Alarm
6. Monitoring and Control at OIT/SCADA:
    a. Marjorie Pump Station Control Reset Pushbutton
    b. Marjorie Pump Station Control Panel Alarms Enable/Disable and Time Delay Setpoints

B. Loop 205 –Wet Well Monitoring
1. General: Raw sewage is stored in a single wetwell. The level in the wetwell shall be continuously monitored by a single submersible pressure transducer (LE/LT-205). The level shall be displayed and trended at the OIT. Two narrow angle float switches, one high-high (LSHH-205A) and one low-low (LSLL-205), shall be used for alarming. One wide angle float switch (LSHH-205B) shall be used for backup float control.
2. Field Instruments:
    a. LE/LT-205: Submersible Level Element and Transmitter
    b. LSLL-205: Low-Low Level Float Switch
    c. LSHH-205A: High-High Level Float Switch
    d. LSHH-205B: High-High Level Float Switch (Backup Control)
3. PLC:
    a. The PLC shall monitor the wetwell level and calculate the % full and feet of the wet well. The level shall also be trended and displayed graphically from 0.0-100.0% full.
    b. The PLC shall activate a Wetwell Low Level Alarm and a Wetwell High Level Alarm based on adjustable setpoints with the ability to enable/disable the alarm (delay 0-600s, initially 10s). Refer to Drawing C-4 for initial elevations.
    c. The PLC shall activate a Level Instrument Fail Alarm if the measured level is out of range (delay 0-600s, initially 5s).
    d. The PLC shall activate a Wetwell High-High Level Alarm when the contact for float LSHH-205A activates (delay 0-600s, initially 5s).
    e. The PLC shall activate a Wetwell Low-Low Level Alarm when the contact for float LSLL-205 activates (delay 0-600s, initially 5s).
    f. The PLC shall activate a Backup Control Float Active Status when the contact for float LSHH-205B activates (delay 0-600s, initially 5s).
4. Alarms at OIT/SCADA:
    a. Marjorie Pump Station Wetwell High-High Level Alarm
    b. Marjorie Pump Station Wetwell High Level Alarm
    c. Marjorie Pump Station Wetwell Low Level Alarm
    d. Marjorie Pump Station Wetwell Low-Low Level Alarm
    e. Marjorie Pump Station Backup Control Float Enabled Alarm
    f. Marjorie Pump Station Wetwell Level Instrument Fail Alarm
5. Monitoring and Control at OIT/SCADA:
    a. Marjorie Pump Station Wet Well Level and Trend (%, ft)

b. Marjorie Pump Station Backup Control Active Status
c. Marjorie Pump Station High and Low Level Alarm Setpoints
d. Marjorie Pump Station Wet Well Alarm Enable/Disable, and Time Delay Setpoints

C. Loops 210 and 211 – Marjorie Street Sewage Pumps

1. General: Two submersible Sewage Pumps (P-1,2) convey sewage from the wetwell to the forcemain. Each pump shall be driven from a VFD and run at constant speed.
   a. Each pump shall have a virtual Manual/Off/Auto switch. In Manual, the pump shall run. In Off, the pump shall not run. In Auto, the PLC shall turn a pump on at the Lead On setpoint and turn the pump off at the Lead Off setpoint.
   b. The pumps shall run in Lead/Standby configuration.
   c. The pumps will have a float backup circuit. When the float (LSHH-205B) is activated, the selected backup pump will turn on and run until the float is deactivated.
2. Field Instruments:
   a. None.
3. PLC:
   a. Pump Monitoring:
      i. The status of the drive shall be displayed at SCADA as RUN/STOP based on the run status contact. The PLC shall totalize the run time hours.
      ii. The PLC shall monitor the status of the LOR switch and display the pump as In Remote/Not In Remote.
      iii. The PLC shall activate a Pump Motor High Temperature Alarm when the contact activates (delay 0-600s, initially 5s).
      iv. The PLC shall activate a Pump Seal Leak Alarm when the contact activates (delay 0-600s, initially 5s).
      v. The PLC shall activate a VFD Fault Alarm when the Fault contact activates (delay 0-600s, initially 5s).
   b. Pump Activation:
      i. The PLC shall control the pump when the Local/Off/Remote selector switch is in the Remote position and the pump is available. The pump is available if the following status conditions are true:
         (1) Motor High Temp Alarm: Inactive
         (2) Seal Leak Alarm: Inactive
         (3) VFD Fault Alarm: Inactive
         (4) Fail Alarm: Inactive
      ii. A Fail Alarm shall be activated if the pump is in Remote and the PLC attempts to start the equipment and the return run contact does not indicate that the motor is running (fixed delay of 60s). The Fail Alarm shall not activate if any other alarm is active.
      iii. The Operator shall be able to set each pump as Lead or Standby. If any pump becomes Unavailable, the pump shall turn Off, and the

pumps shall then alternate. If a pump is unavailable, the PLC shall not command the pump to run or trigger new alarms associated with the pump.

iv. In Remote, the PLC shall provide a virtual Manual/Off/Auto switch. In virtual Off, the pump shall not run. In virtual Manual, the pump shall run.

v. In virtual Auto, the PLC shall activate the lead pump when the level reaches an operator adjustable Lead On setpoint (delay 0-600s, initially 10s). The PLC shall deactivate the pump when the level reaches an operator adjustable Lead Off setpoint (delay 0-600s, initially 10s). Refer to drawing C-3 for initial pump elevations.

c. Alteration:

i. Pump Cycle Auto Alteration shall alternate the Lead and Standby pump every time the Lead pump turns off. The operator shall be able to disable Pump Cycle Auto Alteration.

4. Alarms at OIT/SCADA:
   a. Marjorie Pump Station Pump No.1,2 Motor High Temperature Alarm
   b. Marjorie Pump Station Pump No.1,2 Seal Leak Alarm
   c. Marjorie Pump Station Pump No.1,2 VFD Fault Alarm
   d. Marjorie Pump Station Pump No.1,2 Fail Alarm
5. Monitoring and Control at OIT/SCADA:
   a. Marjorie Pump Station Pump No.1,2 Run Status and Runtime Totalizer
   b. Marjorie Pump Station Pump No.1,2 LOR Status
   c. Marjorie Pump Station Pump No.1,2 Virtual Manual/Off/Auto
   d. Marjorie Pump Station Pump No.1,2 Start Command
   e. Marjorie Pump Station Pump No.1,2 Lead/Standby Selection
   f. Marjorie Pump Station Lead On and Lead Off Level Setpoints
   g. Marjorie Pump Station Pump No.1,2 Cycle Auto Alteration Enable/Disable
   h. Marjorie Pump Station Pumps Alarms Enable/Disable and Time Delay Setpoints

D. Loop 215 – Flow Monitoring
1. General: Flow from the Sewage Pumps is monitored using a 4” electromagnetic flow meter.
2. Field Instruments:
   a. FE/FIT-215: Electromagnetic Flow Meter and Indicating Transmitter
3. PLC:
   a. The PLC shall monitor, display, and trend the flow rate through each flow meter in both gallons per minute (gpm) and million gallons per day (MGD).
   b. The PLC shall calculate a running total in millions of gallons along with a total for Today and Yesterday in gallons x 1000.
   c. The PLC shall activate a Flow Instrument Fail Alarm if the measured flow is out of range (delay 0-600s, initially 30s).

d. The PLC shall activate a Low Flow Alarm if the measured flow is below a Low Flow Setpoint (0.0 to 250, initially 50 gpm) (delay 0-600s, initially 30s).

4. Alarms at OIT/SCADA:
   a. Marjorie Pump Station Flow Instrument Fail Alarm
   b. Marjorie Pump Station Low Flow Alarm
5. Monitoring and Control at OIT/SCADA:
   a. Marjorie Pump Station Flow Rate Display (GPM and MGD)
   b. Marjorie Pump Station Flow Rate Trend
   c. Marjorie Pump Station Flow Totalizer
   d. Marjorie Pump Station Flow Total Gallons (Today)
   e. Marjorie Pump Station Flow Total Gallons (Yesterday)
   f. Marjorie Pump Station Low Flow Setpoint
   g. Marjorie Pump Station Flow Monitoring Alarms Enable/Disable and Time Delay Setpoints

E. Loop 225 – Control Panel Temperature
1. General: The control panel is monitored for low and high temperature conditions using a back panel mounted dual stage temperature switch.
2. Field Instruments:
   a. TSL-225: Low Temperature Switch
   b. TSH-225: High Temperature Switch
3. PLC:
   a. The PLC shall activate a Control Panel Low Temperature Alarm when the contact activates (delay 0-600s, initially 300s).
   b. The PLC shall activate a Control Panel High Temperature Alarm when the contact activates (delay 0-600s, initially 300s).
4. Alarms at OIT/SCADA:
   a. Marjorie Pump Station Control Panel Low Temperature Alarm
   b. Marjorie Pump Station Control Panel High Temperature Alarm
5. Monitoring and Control at OIT/SCADA:
   a. Marjorie Pump Station Control Panel Temperature Alarms Enable/Disable and Time Delay Setpoints

F. Loop 230 – Marjorie Street Generator and ATS
1. General: The PLC shall monitor the state of the ATS and generator and provide load stepping during emergency power startup.
2. Field Instruments:
   a. None.
3. PLC:
   a. Automatic Transfer Switch: The PLC shall monitor state of the ATS for normal or emergency power conditions.
      i. The PLC shall display the status of the ATS position.
      ii. The PLS shall activate an Emergency Power Alarm when the ATS position contact is in the emergency position (delay 0-600s, initially 5s).

iii. The PLC shall activate an ATS Warning if the ATS is not in the Emergency or Normal position (delay 0-600s, initially 60s).

b. Generator: The PLC shall monitor state of the generator conditions.
   i. The PLC shall display the run status of the generator.
   ii. The PLC shall activate a Generator Fail Alarm when the contact activates (delay 0-600s, initially 5s).

c. The PLC shall remove the start command to all equipment when the ATS is not in the Normal to Emergency position.

4. Alarms at OIT/SCADA:
   a. Marjorie Pump Station ATS Emergency Power Alarm
   b. Marjorie Pump Station Generator Fault Alarm
   c. Marjorie Pump Station Generator Low Battery Alarm
5. Monitoring and Control at OIT/SCADA:
   a. Marjorie Pump Station ATS Status
   b. Marjorie Pump Station ATS Warning
   c. Marjorie Pump Station Generator Run Status
   d. Marjorie Pump Station Generator and ATS Alarms Enable/Disable and Time Delay Setpoints

END OF SECTION

SECTION 13444

CONTROL PANELS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Includes:

1. Furnish, install, test, and commission the following panels listed in the control panel schedule.
2. Coordinate with the manufacturers of supplied equipment for specific instrumentation and control requirements. Any deviation in instrumentation or electrical requirements for the supplied equipment shall be provided at no additional cost to the Owner.

B. Related Work Specified Elsewhere:

Section	Title
13410	Instrumentation and Process Control General
13440	Instruments
13441	Control Loop Descriptions
Division 16	Electrical Requirements
Electrical and Instrumentation Drawings	

1.2 QUALITY ASSURANCE

A. The specifications direct attention to certain required features of the equipment but do not purport to cover all details entering into its design and construction. Nevertheless, the Contractor shall furnish the control panels complete in all details and ready for operation.

B. The control panels are an essential component of an integrated system with all plant controls and as such shall be supplied by the System Integrator in accordance with Sections 13410 and 13441.

1.3 SUBMITTALS

A. Submit shop drawings in accordance with the General Conditions of the Construction Contract, Section 01340, Submittals, and Section 13410.

1. Control Panel Layouts, Wiring Diagrams:
    a. Control panel wiring diagrams shall also include ISA S5.4 loop diagrams or equivalent showing point to point wiring for all instrumentation equipment including terminal numbers. Examples of drawings with type of information required are attached to the end of this section. Control panel drawings shall be provided on 11” x 17” format. Loop drawings shall include at a minimum:
        i. Area delineation
        ii. Instrument tagging
        iii. Signal converters, isolators, etc.

iv. Cable / wire numbers
v. Terminal numbers
vi. Junction boxes, terminal boxes, etc.
vii. Control panel, remote IO panels etc.
viii. PLC / IO terminations

2. Bills of Materials (with separate columns for the following: Item Number, Quantity, Manufacturer, Part number, Description, Designator Tag)
3. FAT Report Results
4. SAT Report Results
5. Refer to Section 13410 for additional requirements

1.4 DELIVERY, STORAGE AND HANDLING

A. In accordance with Section 13410

1.5 CONTROL SYSTEM TESTING:

A. Tests Procedures Prior to Start-up:
1. Refer to Section 13410.
2. Factory Acceptance Test (FAT): A witnessed Factory Acceptance Test and verification for all deliverable equipment, software, and associated documentation shall be performed prior to shipment of control systems. The factory tests shall be performed to verify that the control systems are manufactured and assembled correctly, are operating as designed, and are in compliance with the contractual requirements for the deliverables. Communication and integration with Division 11 equipment shall be demonstrated by indication of network addresses and required data tags with forced status/value changes to be witnessed on SCADA.
   a. The Contractor shall schedule Startup and SAT activities with the Engineer at least 5 business day in advance.
   b. The contractor shall plan for testing of no less than 6 hours or all of the panels during any scheduled FAT day.
   c. Prior to the FAT, the SI shall:
      i. Load all firmware onto the PLCs and OITs.
      ii. The SI shall coordinate with the AESS for firmware version to be installed.
      iii. If the PLC or OIT does not have firmware loaded onto the PLC or OIT and the SI directs the AESS to load the firmware, the SI shall be responsible for all costs associated from the loading of the firmware.
   d. The FAT shall include verification and integrated testing of all components. These tests shall include the following.
   e. Visual Inspections: The following inspection checks shall be performed on all deliverable hardware items, as a minimum:
      i. I/O Subsystem physical layout
      ii. Power supply mounting
      iii. Power cable routing
      iv. Data cable routing and mounting
      v. Wiring runs properly separated and installed

vi. Fans, blowers, and heaters are unobstructed
vii. Power supply and power conditioning equipment correctly installed
viii. Wire numbering and color coding
ix. Device labeling
x. Enclosure integrity
xi. Paint work
xii. Control panel lighting
xiii. Panel and enclosure ground connections
xiv. Provide photos:
(1) Panel Exterior
(2) Panel Interior – Door
(3) Panel Interior – Enclosure
(4) Incoming power distribution
(5) PLC
(6) Communications devices
(7) Rear view of enclosure OIT/HMI

f. Relay Logic Checkout:
i. The System Integrator shall perform a complete checkout for all ladder logic circuits to ensure designed functionality.

g. I/O Point Checkout:
i. The System Integrator shall perform a complete checkout for every I/O point from the field wiring terminal strip to the operator interface terminal functions. The System Integrator shall test every input and output point including spares for proper operation. Test signals shall be generated to verify the operation of each Analog Input (AI) and Discrete Input (DI) including connected interposing relays, intrinsically safe circuits and relay circuits. Each Analog Output (AO) and Discrete Output (DO) shall be also tested for proper operation including control circuits, isolation relays, signal conditioner/isolators and other required control circuits.
ii. The System Integrator shall demonstrate that signals are alarmed when reporting under 4 mA and over 20 mA and do not report negative or out of range values.
iii. The System Integrator shall develop a point checkout form for each I/O point. The point checkout form shall include the point ID, description, all checks performed for the point, configured PLC hardware alarms, date and time of the check, and a signoff block for the System Integrator. For each item checked, the form shall include both the expected value/result and the actual value/result witnessed.
iv. The following items shall be checked for each I/O point:
(1) For each analog input point, the following values shall be checked:
(a) Value at -2% of full scale (ramped in both directions)
(b) Value at 0% of full scale (ramped in both directions)
(c) Value at 25% of full scale (ramped in both directions)

(d) Value at 50% of full scale (ramped in both directions)
(e) Value at 75% of full scale (ramped in both directions)
(f) Value at 100% of full scale (ramped in both directions)
(g) Value at 102% of full scale (ramped in both directions)
(h) Each High and Low Alarm condition
(i) Alarm Delay
(j) Alarm Enable/Disable

(2) For each analog output point, the following values shall be checked:
(a) Milliamp reading at 0% of full scale (ramped in both directions)
(b) Milliamp reading at 25% of full scale (ramped in both directions)
(c) Milliamp reading at 50% of full scale (ramped in both directions)
(d) Milliamp reading at 75% of full scale (ramped in both directions)
(e) Milliamp reading at 100% of full scale (ramped in both directions)

(3) For each discrete input point, the following items shall be checked:
(a) For status points, proper indication
(b) For alarm points, proper alarm notification

(4) For each discrete output point, the following items shall be checked:
(a) Proper operation

h. PLC Programming and OIT/SCADA Operation Checkout:
i. Submit the proposed PLC program and OIT/SCADA Configuration (screen printouts) as a shop drawing 15 days prior to the performance of the Factory Acceptance Testing. PLC code shall be a formal submittal.
ii. Verify to the extent possible that the PLC program and OIT/SCADA Operation, as submitted, performs all control and monitoring requirements as described in section 13441 - Control Loop Descriptions. A list of all modifications to the submitted PLC program shall be maintained and submitted after the FAT.

i. 48-Hour Continuous Burn-in Test:
i. After the successful completion of the functional testing specified above, a 48-hour continuous run of each control panel provided shall be performed. The test shall be passed if no function is lost, no hardware or software failure occurs, and no module automatic failover occurs. Hardware failure is defined for this test as the loss

of a major piece of hardware, such as a PLC processor, I/O board, power supply, UPS, other panel equipment, or improper operation by the controller.

ii. During this test, the PLC shall be occasionally (a minimum of 3 times per 24-hour period) exercised with simulated inputs, events, and conditions in a manner that approximates an operational environment in order to verify proper operation.

iii. No programming changes will be allowed to bypass failed modules during this test. Any major software and/or hardware correction made to the control panel shall result in the mandatory rerun of the entire 48-hour test for that control panel.

iv. FAT Report

(1) After FAT, provide and submit a checkout sheet of the FAT. The FAT Report shall include a list of all IO checkout, relay logic checkout, visual, and other QAQC observations.

v. AESS PLC Programming and Network System Testing:

(1) After successful completion of the FAT, the Contractor shall make the control panels available in their shop for 1 day per control panel for functional testing by the AESS for each control panel. The SI will assist with function testing by jumpering or providing signal to I/O during those days. The functional testing shall include testing of both the PLC and OIT descriptions in Specification 13441.

j. If any control panels are shipped to the site without having undergone the specified Factory Acceptance Test; and without the prior authorization by the Engineer, shall be removed from the site and shipped back to the control panel manufacturer's factory for testing at no cost to the Engineer or Owner.

B. Procedures Prior to Start-up:
1. Refer to Section 13410.

C. Onsite Control System Startup:
1. Refer to Section 13410.

PART 2 - - PRODUCTS

2.1 MATERIALS

A. General: Refer to the General Conditions of Section 13440.

B. Intrinsically Safe Equipment
1. Intrinsically Safe Relays:
a. Relays shall be provided for all intrinsically safe sensing or actuation circuits which terminate in hazardous areas.
b. Relays shall be located in non-hazardous areas and installed in accordance with UL requirements.
c. Refer to the instrumentation drawings for signals that require Intrinsically Safe Relays. Relays shall be 120VAC powered.
d. Approvals: FM
e. Equal to:

i. Phoenix Contact
ii. Gems Safe Pak
iii. MTL 7700 Series
iv. or equal

2. Intrinsic Safety Barriers
   a. Barriers shall be provided for all intrinsically safe sensing or actuation circuits which terminate in hazardous areas.
   b. Barriers shall reduce the level of energy as required by intrinsically safe protection between safe and hazardous locations.
   c. Barriers shall be suitable for use with 4 to 20 mA DC signals.
   d. Barriers shall be located in non-hazardous areas and installed in accordance with UL requirements.
   e. Refer to the instrumentation drawings for signals that require Intrinsically Safe Barriers. Barriers shall be 120VAC or loop powered.
   f. Approvals: FM
   g. Equal to:
      i. Phoenix Contact
      ii. Gems Safe Pak
      iii. MTL 7700 Series
      iv. or equal

C. Control Panels
   1. PLC Control Panels (CP):
      a. PLC control panels, furnished by Division 13, shall house all of the required PLC and communications equipment.
      b. For other components in the panels, see Control Panel Components section herein.
      c. A lamicoid label on the door of the enclosure shall identify the PLC Control Panel. Label shall include the panel tag number and the panel name as indicated on the Instrumentation Drawings and in the list below.
      d. The enclosure ratings shall be NEMA 12 or NEMA 4X, refer to Electrical drawing E-1 for NEMA ratings required by area.
      e. Refer to Electrical power plans and control panel schedule for maximum panel sizes (use scaled drawings).
   2. PLC Control Panel Requirements
      a. Each control panel enclosure shall be a NEMA 4X enclosure. The panel shall be sized by the System Integrator house all equipment and room for 20% I/O expansion and meet UL 508A or UL698 requirements, as required by location of intrinsically safe relays or barriers.
      b. All control components shall be mounted using a 35 mm DIN rail.
      c. The center of the Operator Interface Terminal (OIT), Human Machine Interface (HMI), or panel mounted transmitter shall be mounted no higher than 67" and no lower than 63" above the finished floor elevation where an operator will stand.
      d. Provide 12”x12” space for a future radio modem. All equipment needed to establish a functioning communication system will be provided, installed, and configured by the owner.

e. Floor mount Panels will be located on a 4" high housekeeping pad. Provide a window-kit for outdoor installation.
f. Provide heat dissipation and heating calculations of all heat loads for all heated or cooled panels to be included as part of the shop drawing review for this equipment. Design ambient air temperature shall be 0°F for heating and 95°F for cooling.
g. Insulation requirements for heated or cooled panels:
    i. 1” Rigid Fiberglass Insulation installed. The insulation shall:
        (1) Be of a type that conforms with ASTM C612 Type 1VB, C795
        (2) Be installed using mechanical fastening or an adhesive that is listed with a MAGW2 rating.
    ii. Panels that rely on the on the panel thermal transfer for cooling only or indoor panels may not use insulation.
h. Outdoor installations:
    i. Provide a dead-front enclosure with front panel components mounted to the interior swing-door kit.
    ii. Provide enclosure with provisions for mounting in a NEMA 4X enclosure.
    iii. If a dead-front enclosure is not provided as noted on drawings, a window kit and sunshield shall be provided for OIT/HMI installation.
    iv. Conduit penetrations on top of enclosure shall not be permitted.
    v. Provide a door stop kit to prevent doors from opening further than 120°.
i. Unheated spaces or general outdoors:
    i. Shall be equipped with a factory installed built-in heater and adjustable thermostat to heat enclosure to the minimum operating temperature of the installed devices.
    ii. The heater shall include a fan to circulate the air within the enclosure to prevent hot spots. Thermostat shall measure air temperature, not surface temperature.
    iii. Heater shall be Hoffman Enclosures DAH, Saginaw SCE series, or approved equal.
    iv. For smaller panels where an enclosure heater would exceed the requirements (temperature, spacing), provide a strip heater with thermostat for condensation control.
    v. Panel heaters shall be installed in the bottom 1/3 of the control enclosure to assist in thermal efficiency.
    vi. Refer to above for insulation requirements.
j. The enclosure shall open with a padlock-able three-point latch.
k. All equipment shall be DIN rail mounted to a subpanel in the enclosure.
l. Provide an LED enclosure light fixture for each panel door at the top of the enclosure with an accessible On/Off switch. The receptacle and panel light shall be provided with a separate overcurrent protective device and

connected in such a manner so as to not disconnect control, instrumentation, or PLC power in the event that the GFI outlet should trip.

m. Each PLC control panel shall have a UPS. See UPS section below for specific UPS requirements. The UPS shall be mounted inside of the enclosure on a specific UPS shelf which keeps it off of the floor of the enclosure. Provide a UPS maintenance bypass switch (MBS) that allows the panel to be powered through the UPS or from line power, refer to schematics for additional details.

i. Unless stated otherwise each field instrument whether powered by 120 VAC or 24 VDC shall be powered from the associated Control Panel's UPS. Field instruments that measure processes that are not disrupted during a power outage, require a significant amount of time to reset after power is restored from a power outage, or will cause disruptions to process control if the process value is not immediately available once power is restored shall be backed up by the UPS from the associated Control Panel.

ii. The following shall NOT be powered from the UPS:

(1) Control panel lighting.
(2) Control panel heating.
(3) Control panel cooling.
(4) Instrumentation powered from control panel, but not indicated by UPS power as indicated on the Instrumentation and/or Electrical Drawings.

D. Components and Requirements:

1. Enclosures

a. Shall be either UL508A or UL698 Listed as an assembly, as required by location of intrinsically safe relays or barriers.

b. Enclosures shall be sized as required to contain the necessary apparatus for the particular installation. Final panel/enclosure dimensions shall provide for easy access to all internal components with ease of maintenance and future modifications considered. Enclosure size shall accommodate UL requirements. Conflicts with panel sizing and available spacing shall immediately be brought to the attention of the Engineer prior to proceeding to procurement. Panels purchased without submittal/Engineer approval that present installation/egress/clearance issues shall be replaced by the Contractor at no additional cost to the Owner/Engineer.

c. Panels larger than 36-inches in width or 48-inches in height shall not be wall mounted. Provide two doors if panel is larger than 36-inches wide.

d. Enclosures larger than 16" in any dimension shall utilize a three-point latching system.

e. Provide door and body stiffeners where necessary for a rigid enclosure. Floor mounted enclosures shall be provided with lifting eyes and, where floor-mounted, with 12-inch floor stands. No floor stands are to be provided for free-standing models.

f. Doors shall have side mounted, stainless steel, continuous length, piano-type hinges and pins.
g. Panels/enclosures shall be equipped with print pockets located on the inside of the door.
h. A complete “As-Built” panel wiring diagram including exterior devices and motors to be connected shall be encased in clear re-sealable plastic pouch(es) and placed in the print pocket.
i. NEMA 4X stainless steel enclosures shall be Type 304 stainless steel enclosures shall be 16 gauge for box sizes up to and including 24" by 24", 14 gauge for box sizes larger than 24" by 24" up to 36" width, and 12 gauge for box widths greater than 36 inches. Free-standing enclosures shall be 12-gauge minimum. Enclosures shall have continuously welded seams, ground smooth, supplied with no holes or knockouts and a rolled lip around door and enclosure opening. Enclosures to be installed outdoors shall be provided with drip shields. Provide oil-resistant door gaskets all around door openings. All enclosure hinges, clamps, etc. shall be stainless steel. Enclosures/panels shall be provided unpainted, with metal enclosures having a smooth brushed finish.
j. Provide enclosures equivalent to:
    i. Saginaw Control and Engineering
    ii. Hoffman
    iii. Or equal

2. Control Panel Wiring Requirements:
    a. All control panel wiring shall conform to the latest requirements of NEC and all state and local code requirements.
    b. Bundles of wires not in raceways must be secured to the panel structure every 8 inches minimum. All interior wiring will be point to point with no splices.
    c. Wires to the front of panel devices shall be looped, extra flexible, bundled and located in a manner to prevent damage due to opening and closing the door.
    d. All control wires internal to panels shall be minimum No. 14 AWG. Wires carrying line voltage shall be minimum No. 12 AWG. All conductors shall be copper. Wiring in close proximity to heating devices shall be Type AVA UL approved. All wiring shall be run in PVC wiring channels and bundled with nylon cable ties. Line voltage wiring must be run separately from control, signal and intrinsically safe wiring. PVC wiring channels shall be properly sized for the capacity of wires being installed based on the overall project needs and shall not be over filled.
    e. Discrete and analog wiring shall be separated to the greatest extent possible. It shall be assumed that discrete and analog conduits shall be installed into the panel on opposing sides. PLC I/O modules slots and field terminal blocks shall be grouped by type. I/O entry shall be indicated on the drawings as required by UL508.
    f. Wiring to equipment shall be distributed to the greatest extent possible amongst the PLC IO modules to minimize the amount of common failure

points across common equipment. Example: If there are four DI modules and four raw water pumps, each DI module shall have IO for one of the raw water pumps.

g. All network devices shall be powered with redundant power supplies.
h. Analog wire shields shall be continued until the PLC I/O modules.
i. All main, feeder, and branch circuits shall be provided overcurrent protection. PLCs, OITs, HMIs, instruments, power supplies (if not supplied with a field resettable fuse), spare circuits, and networking equipment shall have a dedicated fuse. Overcurrent protection shall be sized appropriately and account for inrush currents.
    i. Main panel circuit protection shall be a fused disconnect.
    ii. Feeder 120 VAC circuits shall use breakers for circuit protection. 24VDC branch circuits may use breakers or fuses.
    iii. All outgoing power (120 V and 24 V) to field devices shall be fused.
    iv. All loop powered devices shall be fused.
    v. Each PLC module shall have a dedicated fuse.
    vi. Fuse and circuit breaker sizing is the responsibility of the System integrator.
j. All wires shall be marked at both ends with numbers by self-sticking wire markers or with slip-on style plastic markers. Wire markers shall match the terminal block labels, unless otherwise specified.
k. Wire color coding shall include the following:
    i. Red wires - Interior control circuits
    ii. Yellow wires - Power from external sources
    iii. Blue wires - DC voltages
    iv. Blue/White wires – DC return (i.e.-24VDC)
    v. Green wires - Ground
l. Terminals shall be arranged in alphabetic and numeric order in columns on removable sub-plates. A maximum of two connections shall be made to each side of a terminal, including jumpers. Provide an additional 20 percent spare terminals for each control panel with the following minimum requirements:
    i. Power terminals
        (1) 1 spare 120VAC
        (2) 1 spare 24VDC
    ii. Control terminals
        (1) 5 spare
    iii. Signal terminals
        (1) 1 spare non-loop powered
        (2) 1 spare loop powered
m. Provide ground terminal for each panel.
n. All control panels shall be provided with spare mountings for additional relays. Number of spare mountings will correspond to 5% of the total number of relays within each panel, with a minimum of one (1) spare mounting.

o. All wiring entering and leaving control panels shall be terminated on field terminal blocks and labeled.
p. Provide individual surge protection for all for all field instruments mounted outside of the building or facility housing the control panel and/or as indicated on the drawings. Instruments mounted within the same structure as the associated control panel do not require surge protection.
q. Provide protection on all signal and data circuits that leave a building or are routed external to a building. Data circuit protection shall be provided at both ends of the signal or data highway lines within the control panel at one end and as close to the instruments or termination device as possible. Refer to drawings for additional requirements.
r. Provide equipment labels for all devices on the subpanel to easily identify panel components (relays, network switches, power supplies, etc.) Labels on equipment is not acceptable.
s. Provide a label indicating the power source on the front of each panel. As-built Panel drawings shall also indicate power source.
t. Wiring shall be in compliant with the National Electric Code and with the applicable UL requirements. All wiring shall be done with best practices and follow equipment manufacturer guidelines.
u. Provide complete "As Built" wiring diagrams to be provided with the O&M manuals and in the enclosures for all control panels.

3. Programmable Logic Controller (PLCs):
   a. General: Provide Programmable Logic Controllers (PLC) in the control panel as identified on the Instrumentation Drawings, capable of performing the functions and handling the network communications as described in Section 13440 and 13441.
   b. The Programmable Logic Controller (PLC) shall be capable of performing the functions and handling the network communications as described in Section 13440 and 13441.
   c. The following Control Panels provided by Division 13 shall have a PLC:
      i. Marjorie Pump Station Control Panel (MCP)
   d. PLC Min. Memory: 1 MB of programmable memory with battery backed-up static RAM.
   e. Max. Scan Time: 1 ms/K
   f. Max. Bit Execution Time: 0.4 microseconds
   g. Power: 110/220 VAC power supply. Each PLC and Remote I/O Module shall be powered by an uninterruptible power supply (UPS)
   h. Required agency approvals:
      i. UL Listed (UL 508)
      ii. CSA Certified (CSA 142)
   i. PLC External Communications: The PLC shall contain both an RS-232/485 Port and an Ethernet port.
   j. Programming and diagnostic software shall be Windows based via Relay Ladder Logic (RLL) custom programming tools for the PLCs. Provide all necessary programming time required to configure each PLC to provide complete control and monitoring functions as described in Sections 13440

and 13441 and as finalized in the instrumentation meetings described below. All licensed PLC development and programming software shall be provided on CD ROM.

k. Provide memory module and battery backup.

l. PLC and Remote I/O Requirements:
   i. Discrete Inputs: 120 VAC and 24 VDC as required, maximum of 16 points per module.
   ii. Discrete Outputs: 120 VAC Relay outputs. Maximum of 16 points per module.
   iii. Analog Inputs: 4-20 mA DC, minimum 12-bit resolution. Maximum 8 channels per module. Provide differential Inputs.
   iv. Analog Outputs: 4-20 mA DC, minimum 12-bit resolution. Maximum 8 channels per module. Provide differential Outputs.

m. Future Connections: Provide a minimum of the following for future connections:
   i. 20% additional discrete inputs per PLC (rounded up) wired to terminal blocks
   ii. 20% additional discrete outputs per PLC (rounded up) wired to interposing relays and terminal blocks
   iii. 10% with a minimum of four (4) additional analog inputs per PLC wired to terminal blocks
   iv. 10% with a minimum of two (2) additional analog outputs per PLC wired to terminal blocks
   v. two (2) module spaces for future input, output, or special modules

n. Spare Parts: Provide a minimum of the following spare parts for Division 13 panels only:
   i. None.

o. Acceptable Programmable Logic Controller (PLC):
   i. Allen Bradley CompactLogix 1769-L24
   ii. No Equal

4. Operator Interface Terminal (OIT):
   a. General: Provide an Operator Interface Terminal (OIT) on the control panels as identified on the Instrumentation Drawings, to continuously indicate status of equipment, change operational parameters and indicate alarm status as described in Section 13441. The OIT shall be fully compatible with the PLC provided.
   b. The following Control Panels provided by Division 13 shall have an OIT:
      i. Marjorie Pump Station Control Panel (MCP)
   c. Screen Size: 10”
      i. Color active matrix screen with a minimum resolution of 640 by 480 pixels with field replaceable backlight, screen size identified in Panel Schedule below.
   d. Interface: Touchscreen rated at 1 million cycles (minimum).
   e. Memory: 64 MB minimum application and graphic memory. The OIT shall also include an SD or USB port. Provide a compatible memory card.
   f. Clock: Provide integral real time clock with battery backup.

g. Communication: RS-232, Ethernet and USB ports.
h. Power: 120 VAC or 24 VDC
i. Operating Temperature: 32-130°F
j. Enclosure: NEMA 12 with NEMA 4X front-face and touchpad
k. Classification: To match panel.
l. Provide programming time required to configure OIT interface as described in Section and finalized in the instrumentation meetings.
m. Provide all cables required to connect the OIT to the network or PLC.
n. The integrated OIT software shall have the following features:
    i. Trending
    ii. Data Logging
    iii. Alarms
    iv. Graphic Symbols
    v. Animation
o. Acceptable Operator Interface Terminal (OIT):
    i. Automation Direct PanelView C-More
    ii. No Equal

5. Uninterruptible Power Supply (UPS):
    a. Provide an uninterruptible 120-volt backup power supply for each PLC, OIT, Ethernet switch or other device as shown on the Drawings to maintain continuous operation of PLCs, operator interface terminals, Ethernet switches, monitoring instrumentation and control and process circuits during a power outage.
    b. UPS type shall be provided as a continuous-duty, on-line, solid state, double conversion, single-phase 120 VAC input, single-phase 120VAC true sinewave output uninterruptible power system with auto-bypass. The UPS shall be provided with surge arresting capabilities to prevent sudden surges to the attached electrical control systems.
    c. The UPS will be inside the control panel, located in the bottom section of floor stand type control panels or provided an independent wall mounted enclosure. The UPS shall be installed per UL 508 requirements and be powered by a simplex outlet.
    d. UPS shall be installed in a manner to not impede access to terminals or field wiring.
    e. Provide appropriate maintenance bypass switch as specified herein to easily remove and bypass the UPS.
    f. The UPS shall have “hot-swappable” batteries and be capable of being replaced with the UPS in operation. The run time operation of the UPS shall be accomplished using batteries mounted within the UPS enclosure and supplemented as necessary with batteries in an enclosure to provide the battery runtime specified herein. The battery enclosure shall match the main UPS enclosure as closely as possible.
    g. The UPS shall be type rated for industrial use and capable of supplying standby power to all connected control panel equipment and circuits at peak load for a minimum of fifteen (15) minutes at full load, thirty (30) minutes half load. UPS minimum rating shall be 750 VA.

h. Acceptable manufacturers:
   i. Schneider Electric APC Smart-UPS
   ii. Liebert GXT3 Series
   iii. Tripp-Lite SU Series
   iv. Eaton Powerware
   v. or equal.

6. Unmanaged Ethernet Switches:
   a. General
      i. Provide unmanaged Ethernet switch(s) for connection to the control network as shown in the Drawings and specified herein.
   b. Physical Features
      i. Copper ports: 6
      ii. PoE Copper ports: 2
      iii. Fiber ports: 0
      iv. Operating temperature: 32 to 130 degrees f
      v. Power: 24 VDC
      vi. Enclosure: Metal case, DIN-rail mountable
      vii. Rating: ANSI/ISA Class 1, Division 2 Groups A, B, C, and D
   c. Network Features
      i. Auto sensing duplex and speed
      ii. LED link/activity status indication
   d. Acceptable Manufacturers
      i. Phoenix contact
      ii. N-Tron
      iii. Moxa
      iv. Or equal
   e. Basis of design: The drawings are based on generic network equipment. Equivalent alternate equipment will be considered provided that all revisions required to the design be accomplished at no cost to the owner.
7. Data/Power Port:
   a. Provide a Data/Power port with Ethernet RJ45 jack and 120 VAC GFI outlet to meet Arc flash 70E requirements. Data power port will have a lockable hinged cover with panel mounted hardware and shall be installed on the front of the control panel.
   b. Control panels with a keyboard shall have a Data/Power port with a USB connection.
   c. Environmental Rating: To match panel NEMA rating.
   d. The Data and Power port shall be:
      i. Grace Engineered Products
      ii. Hubble "Panel-Safe" Power and Data Access Ports
      iii. Or equal
8. 12 and 24 VDC Power Supplies:
   a. Provide 12 and 24 VDC power supplies in the control panel to power field instruments, panel devices, etc., as required.

b. No more than three internal panel devices or external field instruments requiring 12 or 24 VDC power shall be powered from a single 12 or 24 VDC power supply.
c. Input voltage: 115 VAC
d. Output voltage: 24 or 12 VDC.
e. Ripple: <50 mVpp.
f. The power supply shall be sized to accommodate 125% of the design load.
g. Operating temperature: 32 to 140 °F.
h. The power supply shall be provided with a means to protect instruments from over current and over voltage.
i. Mounting: Din rail mount inside enclosures. Power supply shall be located in the enclosure such that heat generated does not cause other panel components to malfunction or become damaged.
j. 12 or 24 VDC power supplies shall be:
    i. Sola SDN
    ii. Allen-Bradley 1606
    iii. or Equal

9. Hand Switches: HS
    a. Push buttons and selector switches shall be 30 mm and heavy duty oil-tight.
    b. Switches shall have the same NEMA rating as the panel that the switch is installed in.
    c. Contact blocks shall be stackable and provide all necessary contacts as shown on the Drawings.
    d. Each switch shall be labeled as indicated on the Drawings.
    e. Equal to:
        i. Allen Bradley 800H series
        ii. Eaton Cutler-Hammer HT800 series
        iii. Or equal
10. Indicator Lights: YL, AL
    a. All indicator lights shall be 30 mm, heavy duty oil-tight, 120 VAC, LED with push to test option. Indicator Lights shall be wired such that they can be tested with Control or UPS Power source.
    b. Lights shall have the same NEMA rating as the panel that the light is installed in.
    c. Indicator lights shall be provided with a chrome-plated metal or anodized-aluminum mounting rings, engraved as indicated on the Drawings.
    d. All indicating lights will use the following light color convention: See Instrumentation Drawing I-1 “Indicator Light Color Legend”.
    e. Equal to:
        i. Allen Bradley 800H series
        ii. Eaton Cutler-Hammer HT800 series
        iii. Or equal
11. Fuses:
    a. Fuses shall be 3AB ceramic body fuses rated for at least 125 volts at the current ratings shown on the Drawings. Fuse size shall be ¼” by 1¼”.

b. Blow time shall be: 110%, 4 hours minimum; 135%, 1-hour maximum; 200%, 15 seconds maximum for 1/8-12 amp fuses and 60 seconds maximum for 15-30 amp fuses.
c. Fuses shall be:
    i. Entrelec
    ii. Bussmann,
    iii. Or approved equal.

12. Line Surge Protection:
    a. A UL1449 dedicated surge protection device (non-UPS) shall be installed for main power into a panel.
    b. A UL1449 dedicated surge protection device (non-UPS) shall be installed for panel powered instruments located outside of the building.
    c. Surge protection shall protect L-G, L-N and N-G.
    d. Surge arrestor shall be adequate for intended function and shall be by a nationally recognized manufacturer with a minimum of 3-years' experience in manufacturer of such devices. Technology shall a hybrid of Silicone Avalanche Diodes and MOV or MOV and thermal fusing. GDT or sole MOV technology is not acceptable.
    e. Surge arrestor to include a dry contract for remote monitoring of a surge event.
    f. Surge arrestor shall be installed per manufacturer recommendations, as close to incoming power as possible, and incoming leads shall be as short as possible.
    g. Surge arrestor shall have a positive indication of device operation or failure.
    h. Surge arrestor shall have a Surge Current rating of 25kA per phase.
    i. Surge Arrestor shall be:
        i. Weidmuller SPD series
        ii. Citel DS40 series
        iii. Or Equal
13. Control Relays:
    a. Scope: Control relays used for relay logic.
    b. Relays shall be electrically held, Form C, electrically operated with 120 volt coils except as noted otherwise on the Drawings. Contacts shall be rated 10 amps at 600 volts or higher as required by the application.
    c. The number of poles required shall be determined by the System Integrator depending on specific requirements of what the relay is used for. Each relay will be at minimum DPDT or one spare pole per relay.
    d. Control relay shall have an energized indicator in either the form of a mechanical flag, or neon lamp (LED for DC applications).
    e. Relays shall be provided with a suppression diode for inductive loads.
    f. Control Relays shall be:
        i. Allen Bradley 700-HF Series
        ii. Idec RU Series
        iii. Or equal
14. PLC Output Relays:

a. Scope: Control relays used for PLC outputs (isolation relays)
b. Each PLC discrete output shall be protected with an interposing relay including spare PLC discrete outputs. PLC output relays shall be SPDT electrically held, Form C, electrically operated with 120 volt coils. Contacts shall be rated at a minimum 5 amps at 300 volts. System Integrator shall use higher capacity relays for equipment that is being powered directly through the relay's contacts.
c. Control relay shall have an energized indicator in either the form of a mechanical flag, or neon lamp (LED for DC applications).
d. PLC output relays shall be DIN rail mounted and have a slim profile in order to conserve panel space.
e. Relays shall be provided with a suppression diode for inductive loads.
f. Control Relays shall be:
    i. Allen Bradley 700HK Slim Line Series
    ii. Phoenix Contact PLC relay series
    iii. Or equal

15. Automatic Transfer Relays (ATR)
    a. Scope: ATRs shall be Contactors or IEC control relays are used for the ATR circuit. Devices shall be IEC listed.
    b. Relays shall be 4NO and 4NC at a minimum and have an auxiliary contact to indicate to the PLC the ATR fail status. The number of poles required shall be the responsibility of the system integrator.
    c. Relay coil shall be actuated via 120VAC except as noted otherwise on the Drawings.
    d. Contacts shall be thermally rated for 16A continuously (for 20A panel, or as required by feeder circuit current) at 120VAC and shall be mechanically linked. Auxiliary contacts shall be rated for 5A at 120VAC.
    e. Relay shall provide positive safety for the N.O. and N.C. contacts which assure that the N.O. contacts will not close before any N.C. contact opens
    f. Equal to:
        i. Allen Bradley 700-CF series
        ii. ABB N44 series
        iii. Or equal
16. Terminal Blocks
    a. Field terminal strips with box type connectors shall be supplied to make all power, control, and signal connections to and from each control panel.
    b. All terminals shall be clearly marked for easy identification. A ground terminal strip shall also be provided.
    c. Field terminal blocks shall be single tier for ease of installation and maintenance.
    d. At least 20 percent of terminals supplied shall be spare. All wiring in and out of a control panel shall be terminated on field terminal blocks.
    e. All spare PLC I/O (including interposing relays) shall be wired to terminal blocks.
    f. Prewired terminal blocks from the PLC manufacturer as also acceptable. The prewired terminal blocks shall also meet the specifications herein.

g. Field Terminal Blocks shall be:
   i. Phoenix Contact UT Series
   ii. Allen-Bradley 1492 Series
   iii. Or equal

17. DIN Rail
   a. Size: 35mm
   b. Material: Aluminum or Bronze
   c. All field terminal blocks shall be mounted on 2” raised DIN rail
18. Spare Parts and Test Equipment:
   a. The System Integrator shall furnish the following spare parts :
      i. 2 surge suppressors of each type
      ii. 1 24 VDC Power Supply of each type
      iii. 3 of each type lamp, unless otherwise specified herein
      iv. 2 of each color indicator light lens.
      v. 5 control relays (of each type)
      vi. 1 complete selector switch of each type.
      vii. 1 complete push-button of each type.
      viii. 1 of each different contact block for control units.
      ix. 1 breaker of each type
      x. 1 fused disconnect of each type
      xi. 1 box of every type of fuse in every panel provided.

PART 3 - - EXECUTION

3.1 INSTALLATION

A. General: Refer to Section 13410 PART 3 - EXECUTION.

PANEL SCHEDULE

Description	Abbreviation	Type	NEMA Rating	Panel Width*	Mounting*	Shelf & Keyboard	Marshaling Shelf	UL Rating
Marjorie Street Control Panel	MCP	CP	4X	36”	Wall	No	No	698

*The panel width and mounting are the dimensions and arrangements shown on the electrical plans for reference. System Integrator is responsible for working with the General Contractor and adhering to the specifications.

END OF SECITON

SECTION 15050

PIPE & PIPE FITTINGS – GENERAL

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Furnish, install, support, and test pipe and pipe fittings of the type(s) and size(s) and in the location(s) shown on the Drawings and as specified herein.

B. Related Work Specified Elsewhere (When Applicable):
   1. Excavation and backfill are specified in Division 2.
   2. Painting and Pipe Identification are specified in Section 09900.
   3. Surface Preparation and Shop Coatings are specified in Section 09905.
   4. Valves, gates, pipe hangers, pipe supports, pipe and equipment insulation, heating, and plumbing are specified in the appropriate Sections in Division 15.
   5. Pipe materials are specified in the appropriate sections of Division 2 and/or Division 15.

C. Other Trades: Cooperate with all other trades whose work is to be coordinated with piping work.

1.2 REFERENCES

A. American National Standards Institute (ANSI)
   1. ANSI B31.1 – Power Piping
   2. ANSI B31.3 – Process Piping
   3. ANSI B31.4 – Liquid Transportation Systems for Hydrocarbons,
   4. Liquid Petroleum Gas, Anhydrous Ammonia, and Alcohol.
   5. ANSI B31.5 – Refrigeration Piping
   6. ANSI B31.9 – Building Services Piping
   7. ANSI B31.8 – Gas Transmission and Distribution Piping Systems

1.3 SUBMITTALS

A. Submit shop drawings in accordance with Section 01340 and the General Conditions of the Construction Contract.

B. Submit manufacturer's "Certification of Conformance" that pipe and fittings and other piping appurtenances meet or exceed the requirements of these Specifications.

C. Submit other documents as specified in the appropriate Sections of this Division.

D. Submittal shall include catalog cut for each different type of pipe hanger or support indicating the materials of construction, dimensions and range of pipe sizes for which that hanger is suitable. Where standard hangers and/or supports are not suitable, submit detailed drawings showing materials and details of construction for each type of special anchor and/or support.

E. After the work is installed, but before it is filled for start-up and testing, the support system design engineer shall inspect the work and certify its complete adequacy. Each system shall be inspected and certified in the same way. Submit a report, including all field modifications and all certificates.

1.4 SEISMIC CONTROL

A. Not applicable.

1.5 DELIVERY, STORAGE AND HANDLING

A. Exercise care during loading, transporting, unloading, and handling to prevent damage of any nature to interior and exterior surfaces of pipe and fittings.
B. Do not drop pipe and fittings.
C. Store materials on the project site in enclosures or under protective coverings in accordance with manufacturer's recommendations and as required by the Engineer.
D. Assure that materials are kept clean and dry.
E. Do not store materials directly on the ground.
F. Follow manufacturer's specific instructions, recommendations and requirements.
G. Store in a manner to protect items with epoxy shop coatings from exposure to UV light which can cause chalking of the epoxy. Length of acceptable exposure prior to providing UV protective measures shall be in accordance with coating manufacturer's recommendations. This includes protection from UV light after installation while awaiting covering or filling of tanks, or prior to field painting for items scheduled to be top coated as specified in Section 09900.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials are specified in the following Sections in this Division.

2.2 SURFACE PREPARATION AND SHOP COATINGS

A. Provide surface preparation and shop coatings in accordance with Specification Section 09905.

PART 3 - EXECUTION

3.1 INSPECTION

A. Provide all labor necessary to assist the Engineer to inspect pipe, fittings, gaskets, and other materials.
B. Carefully inspect all materials at the time of delivery and just prior to installation.
C. Carefully inspect all pipe and fittings for:
    1. Defects and damage.
    2. Deviations beyond allowable tolerances for joint dimensions.
    3. Removal of debris and foreign matter.
D. Examine areas and structures to receive piping for:
    1. Defects, such as weak structural components that adversely affect the execution and quality of work.
    2. Deviations beyond allowable tolerances for pipe clearances.
E. All materials and methods not meeting the requirements of this Contract will be rejected.
F. Immediately remove all rejected materials from the project site.
G. Start work only when conditions are corrected to the satisfaction of the Engineer.

3.2 INSTALLATION

A. General:

1. Install all pipe and fittings in strict accordance with the manufacturer's instructions and recommendations and as specified herein.
2. Install all pipes and fittings in accordance with the lines and grades shown on the Drawings and as required for a complete installation.
3. Install adapters, acceptable to the Engineer, when connecting pipes constructed from different materials.
4. Support all piping not being installed in trenches in accordance with the "Pipe Hangers & Supports" Section in Division 15.

B. Installation in Trenches:

1. Firmly support the pipe and fittings on bedding material as shown on the Drawings and as specified in the appropriate Sections of these Specifications.
2. Do not permanently support the pipe or fittings on saddles, blocking stones, or any material which does not provide firm and uniform bearing along the outside length of the pipe.
3. Thoroughly compact the material under the pipe to obtain a substantial unyielding bed shaped to fully support the pipe.
4. Excavate suitable holes for the joints so that only the barrel of the pipe receives bearing pressure from the supporting material after placement.
5. Lay each pipe length so it forms a close joint with the adjoining length and bring the inverts to the required grade.
6. Set the pipe true to line and grade.
7. Do not drive the pipe down to grade by striking it with a shovel handle, timber, rammer, or any other unyielding object.
8. Immediately after making a joint, fill the holes for the joints with bedding material, and compact.
9. When each pipe length has been properly set, place and compact enough of the bedding material between the pipe and the sides of the trench to hold the pipe in correct alignment.
10. After filling the sides of the trench, place and lightly tamp bedding material to complete the bedding as shown on the Drawings.
11. Take all necessary precautions to prevent floatation of the pipe in the trench.
12. Bedding and backfill for all pipe materials shall be as specified in Section 02200, Earthwork, and as shown on the Drawings.

C. Temporary Plugs:

1. When pipe installation work in trenches is not in progress, close the open ends of the pipe with temporary watertight plugs.
2. If water is in the trench when work is resumed, do not remove plugs until all danger of water entering the pipe is eliminated.
3. Do not use the pipelines as conductors for trench drainage during construction.

3.3 CLEANING AND TESTING

A. Cleaning & Testing Piping - General:

1. Thoroughly clean all piping prior to testing. Remove all dirt, dust, oil, grease and other foreign material. Exercise care while cleaning to avoid damage to linings and coatings.
2. When the installation is complete, test all pipelines in the presence of the Engineer and the plumbing or building inspector in accordance with the requirements of the local and state plumbing codes and the appropriate Sections of these Specifications, at no additional cost to the Owner. When requested by the Engineer or local plumbing inspector, building gravity drains shall be tested prior to backfilling or concealing. All other piping must be tested after backfilling.
3. Equipment: Supply all labor, equipment, materials, taps, gauges, and pumps required to conduct the tests.
4. Retesting: Perform all retesting required by the Engineer at no additional cost to the Owner.

B. Outside Potable Water Piping:

1. Pressure Test (CLASS I):
   a. CLASS I Pressure Testing shall be performed in accordance with Section 4 of AWWA Standard C600.
   b. Pressure and leakage tests are required and will be conducted concurrently.
   c. Hydrant branch gate valves shall remain open during this test.
   d. The hydrostatic pressure shall be at the test pressures noted on the Drawings based on the elevation of the lowest point in the Section under test. If no test pressure is indicated, perform pressure and leakage test at 1-1/2 times the maximum system pressure or 150 psi, whichever is greater (based on the elevation of the lowest point of the section under test and corrected to gauge location). Test duration shall be two (2) hours.
   e. Leakage, if any, shall be equal to or less than the amounts as determined by Section 4.2 of AWWA C 600.

$$L = \frac{SD\sqrt{P}}{148{,}000}$$

L = allowable leakage in gallons per hour
S = length of pipe tested, in feet
D = nominal diameter of pipe, in inches
P = average test pressure, in pounds per square inch

   f. The Contractor shall furnish and install corporation stops, taps and lengths of line as required to conduct the testing.
2. Disinfection of Pipelines:
   a. Chlorinate all new potable water lines in accordance with the procedure outlined in AWWA C651. (Section 5.1 deleted)

b. Review locations of chlorination and sampling points with the Engineer prior to beginning disinfection.
c. Use a dosage which will produce an initial minimum concentration of 25 mg/l and not less than 10 mg/l chlorine residual after a contact period of 24 hours.
d. During the chlorination period, exercise care to prevent the contamination of water in the existing water main.
e. After chlorination, flush the piping with clean potable water until the residual is that prevailing in the existing system or less than 0.5 mg/l.
f. The Contractor shall furnish and install corporation stops, taps, lengths of pipe as required to conduct testing.
g. Dispose of chlorinated water as per AWWA C651, Appendix B.

3. Bacteriological Testing:
   a. Test all new potable water lines for total coliform bacteria at no additional cost to the Owner.
   b. The length of pipe to be tested and the time of the test itself shall be as approved in advance by the Engineer.
   c. The Engineer will observe the taking of samples.
   d. Have all samples tested by a laboratory certified by the State and submit test results to the Engineer.
   e. Any segment of a potable water line shall be considered unsuitable for service if a coliform bacteria count is obtained from that sample or if results show a high non-specific bacteria level.
   f. Re-disinfect all segments of piping considered unsuitable and retest. Continue to disinfect and test until satisfactory results are obtained.
   g. Place piping into service when it has been successfully tested for pressure, leakage and total coliform bacteria and has been accepted by the Engineer.

C. Building Interior or Exposed Water Lines: Clean and test in accordance with the "Plumbing General" Section in Division 15.

D. Building Interior or Exposed Sewer System: Clean and test in accordance with the "Plumbing General" Section in Division 15.

E. Outside Sewer Lines (CLASS II): CLASS II pipe testing shall be performed in accordance with Section 02755.

F. Air Lines (CLASS III):
   1. CLASS III Pressure Testing of Air Lines shall be performed in the presence of the Engineer.
   2. After the pipe has been cleaned, suitable cap ends of pipe.
   3. Introduce pressured air into the sealed pipeline until the air pressure reaches the test pressure indicated in the Pipe Schedule, and remains stable for at least 2 minutes. When no pressure is indicated in the Pipe Schedule, pressure test the air pipe at 15 psig or 150% of the maximum working pressure, whichever is greater.
   4. All interior and exterior air piping shall be air pressure tested at the test pressure indicated above for a test period of 30 minutes with less than 0.5 PSIG pressure loss.

5. Remedial Work:
    a. Perform all work necessary to correct deficiencies discovered as a result of the testing and/or inspections.
    b. Completely retest all portions of the piping on which remedial work has been performed.
    c. Perform all remedial work and retesting in a manner and at a time acceptable to the Engineer, at no additional cost to the Owner.

G. All Other Piping Systems:
1. CLASS IV and CLASS V Hydrostatic Pressure Test:
    a. The section of pipe to be tested shall be filled with water of approved quality, and all air shall be expelled from the pipe. If blowoffs are not available at high points for releasing air the Contractor shall make the necessary excavations, backfilling and taps at such points and shall plug said holes after completion of the test.
    b. The section under test shall be maintained full of water for a period of 24 hours prior to the combined pressure and leakage test being applied.
    c. CLASS IV - Perform pressure and leakage test at the test pressure shown on the Pipe Schedule. If no test pressure is indicated, perform pressure and leakage test at 1-½ times the maximum system pressure or 100 psi whichever is greater (based on the elevation of the lowest point of the section under test and corrected to the gauge location).
    d. CLASS V - Perform pressure and leakage test at the test pressure shown on the Pipe Schedule. If no test pressure is indicated, perform pressure and leakage test at 1-1/2 times the maximum system pressure or 20 psi whichever is greater (based on the elevation of the lowest point of the section under test and corrected to the gauge location).
    e. While maintaining this pressure, the Contractor shall make a leakage test by metering the flow of water into the pipe. If the average leakage during a two-hour period on buried pipelines exceeds a rate calculated by the equation in paragraph 3.3,B,1,e of this Specification Section, the section shall be considered as having failed the test. All pipes within structures and chambers and all flanged joints shall have no visible leakage.
    f. If the section fails to pass the pressure and leakage test, the Contractor shall do everything necessary to locate, uncover, and repair or replace the defective pipe, fitting, or joint, all at their own expense and without extension of time for completion of the work. Additional tests and repairs shall be made until the section passes the specified test.
2. Connection to Work by Others.
    a. If work involves connection of pipe lines to pipes or structures provided by others, pressure tests pipe line prior to making the connection.
    b. After successfully passing the pipe line pressure test, make the necessary connections to the work by others, and pressure test the connection.

c. The connection shall be pressurized to the pipe line test pressure, for a minimum of 4 hours. The connection shall have no visible leakage.
d. Correct any leakage at no cost to the Owner and retest until connection passes.

3. Cleaning: Perform all specialized cleaning as specified or required by system.

3.4 PIPE SCHEDULE

TAG	DESCRIPTION	LOCATION (1)	SIZE	MATERIAL (2)	JOINT SYSTEM	PRESSURE TEST CLASS (3)	DELEGATED PE DESIGN OF PIPE SUPPORTS	DELTA OPER. PRESS. (PSI)	DELTA OPER. TEMP. (degF)
PIPE SCHEDULE PART 1: **PART 1 OF THIS PIPE SCHEDULE APPLIES TO ALL PIPING EXCEPT FOR PLUMBING AND MECHANICAL PIPING. REFER TO PART 2 AT THE END OF THIS TABLE FOR PLUMBING/MECHANICAL PIPING SCHEDULE.**									
FM	FORCE MAIN	BURIED	≥4"	CLASS 52 D.I.	MJ OR PUSH-ON	CLASS IV	N/A	-	-
				SDR 17 HDPE	SEE SPEC 02628		N/A	-	-
		EXPOSED	≥8"	CLASS 53 D.I.	FLANGED		N/A		
			≤6"	CLASS 53 D.I.	FLANGED		NO	-	-
DR	DRAIN	BURIED	≥4"	SCH 80 PVC	SOLVENT WELD		N/A		
							N/A		
NG/ GAS	NATURAL GAS	ALL	SEE SPEC SECTION 15444				N/A	-	-
S	SEWER	BURIED	<30"	SDR 35 PVC	PUSH-ON	CLASS II	N/A	-	-
							N/A	-	-
								-	-
								-	-
W	WATER	BURIED	≥4"	CLASS 52 D.I.	PUSH-ON	CLASS I	N/A	-	-
			< 4"	SCH 80 PVC	SOLVENT WELD	CLASS I	N/A	-	-

(1) Pipe contained within tankage shall be considered “exposed” or “interior” piping for the purposes of the pipe schedule (unless otherwise specifically designated).

(2) Type l copper may be used in lieu of D.I. for 3" ductile iron pipe.

(3) If a specific pressure is not indicated in parentheses after the pressure testing class, use the test pressure indicated in the specification write up for that general pipe pressure testing class.

END OF SECTION

SECTION 15062

DUCTILE IRON PIPE & FITTINGS (INTERIOR/EXPOSED APPLICATIONS)

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Provide and install ductile iron pipe and fittings of the type(s) and size(s) in the location(s) shown on the Drawings and as specified herein.

B. Related Work Specified Elsewhere:
   1. Pipe and Pipe Fittings - General is specified in Section 15050.
   2. Surface Preparation and Shop Coatings are specified in Section 09905.
   3. Ductile Iron Pipe & Fittings for Buried Applications is specified in Section 02615.

1.2 QUALITY ASSURANCE

A. Standards (As Applicable):
   1. Cement-mortar lining for water: ANSI A2l.4 (AWWA C104).
   2. Rubber gasket joints: ANSI A2l.ll (AWWA C111).
   3. Ductile iron pipe thickness: ANSI A2l.50 (AWWA C150).
   4. Ductile iron pipe centrifugally cast in metal or sand lined molds: ANSI A2l.5l (AWWA C151).
   5. Pipe flanges and fittings: ANSI Bl6.l and ANSI A21.10 (AWWA C110).
   6. Threaded, flanged pipe: ANSI A21.15 (AWWA C115).
   7. Cast and ductile iron fittings: ANSI A2l.l0 (AWWA C110).

B. Acceptable Manufacturers:
   1. Griffin
   2. Tyler
   3. Union
   4. US Pipe
   5. Victaulic Company (fittings only)
   6. Or equivalent.

1.3 SUBMITTALS TO THE ENGINEER

A. In accordance with the requirements specified in Section 01340 and 11000. Submit such shop drawings, manufacturer's literature, short-term and long-term storage requirements, and operations and maintenance manuals.

B. Additional specific information for submittal is listed below:
   1. Submit Manufacturer's "Certification of Conformance" that pipe and fittings meet or exceed the requirements of these specifications.
   2. Submit Manufacturer's installation instructions for all pipe and fittings.

1.4 DELIVERY, STORAGE & HANDLING

A. Exercise extra care when handling cement lined pipe because damage to the lining will render it unfit for use.

B. Protect the spherical spigot ends and the plain ends of all pipe during shipment by wood lagging securely fastened in place.

PART 2 - PRODUCTS

2.1 PIPE MATERIALS

A. General:
   1. Unless otherwise shown on the Drawings, the minimum thickness of ductile iron pipe shall be Class 53.
   2. Pipe for use with sleeve type couplings shall have plain ends (without bells or beads) cast or machined at right angles to the axis.
   3. Pipe for use with split type couplings shall have ends with cast or machined shoulders or grooves that meet the requirements of the manufacturer of the couplings and AWWA C606.
   4. The outside of all interior pipe shall be coated in accordance with Section 15050.

B. Pipe Interior Lining:
   1. Pipe shall be double thickness cement lined and seal coated unless noted otherwise on the Drawings and except for air piping lines which shall be completely unlined.

C. Joints (as shown on Drawings or as specified):
   1. Flanged:
      a. Provide specially drilled flanges when required for connection to existing piping or special equipment.
      b. Flanges shall be flat face, long-hub screwed tightly on pipe by machine at the foundry prior to facing and drilling.
      c. Gaskets:
         i. Full face gaskets only.
         ii. Thickness of gaskets - Use standard 1/8-inch thickness gaskets, unless thinner gaskets are required for tight retrofit installations.
         iii. On high temperature applications such as air lines, the gaskets shall be suitable for service from 40°F to 250°F.
      d. Fasteners:
         i. Make joints with bolt, studs with a nut on each end, or one tapped flanged with a stud and nut.
         ii. The number and size of bolts shall meet the requirements of the applicable ANSI standard.
         iii. Nuts, bolts, and studs shall be Grade B meeting the requirements of ASTM A307.
      e. When applicable, provide and install flange clamps as shown on the Drawings.
   2. Grooved Joint Couplings: Couplings shall consist of two or more ductile iron housing segments to ASTM A536, pressure responsive FlushSeal gasket to

ASTM D2000, and zinc electroplated steel bolts and nuts to ASTM A449 or stainless steel to ASTM F593.

a. For direct connection to grooved end IPS/steel pipe sizes transition couplings may be used. The coupling housings shall be cast with offsetting angle-pattern bolt pads for joint rigidity.
b. Split ring couplings, sleeve couplings, flexible joints and couplings, shall be supplied as specified in "Couplings and Connectors" Section.
c. All grooved joint couplings, fittings, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
d. All castings used for coupling housings, and fittings shall be date stamped for quality assurance and traceability.

3. Joint Bracing:
   a. Provide joint bracing to prevent the piping from pulling apart under pressure as required and as shown on the Drawings.
   b. Types of bracing:
      i. Pipe and fittings furnished with approved lugs or hooks cast integrally for use with socket pipe clamps, tie rods, or bridles. Bridles and tie rods shall be a minimum of 3/4 inch diameter except where they replace flange bolts of a smaller size, in which case they shall be fitted with a nut on each side of the pair of flanges. The clamps, tie rods, and bridles shall be coated with bituminous paint in buried installations and shall be coated with the same coatings as the piping system in interior installations after assembly or, if necessary, prior to assembly.
      ii. Other types of bracing as shown on the Drawings.

2.2 FITTINGS

A. Standard Fittings:

1. Either gray cast iron or ductile iron fittings may be furnished.
2. Pressure rating of 250 psi unless indicated otherwise on the Drawings or as specified.
3. Flange fittings shall be ANSI B16.1, Class 125 unless indicated otherwise. Flanges shall be flat faced, with full face gaskets.
4. Grooved end fittings shall comply with ANSI A21.10/AWWA C110 for center-to-end dimensions, and ANSI A21.10/AWWA C110 or AWWA C153 for wall thickness. Ends shall comply with AWWA C606, and the fittings shall be of the same manufacturer as the grooved components.
5. Joints the same as the pipe with which they are used or as shown on the Drawings.
6. Provide fittings with standard bases where shown on the Drawings.
7. Cement lining and seal coat unless noted otherwise on the Drawings, and except for air piping applications where the fittings shall be unlined.
8. All interior fittings shall receive coating in accordance with Section 15050.
9. On high temperature applications such as air lines, the gaskets shall be suitable for service from 40°F. to 250° F.

B. Non-Standard Fittings:
   1. Fittings having non-standard dimensions shall be subject to the Engineer's review and acceptance.
   2. Non-standard fittings shall have the same diameter and thickness as standard fittings and shall meet the specification requirements for standard fittings.
   3. The lengths and types of joints shall be determined by the particular piping to which they connect.
   4. Flanged fittings not meeting the requirements of ANSI A21.10 (i.e., laterals or reducing elbows) shall meet the requirements of ANSI B16.1 in Class 125.

C. Wall Castings:
   1. Size, type and location as shown on the Drawings.
   2. Dimensions shall conform to ANSI A21.10 except where required. A flange substantially flush with the face of a concrete or masonry wall shall be drilled and tapped for studs.
   3. Other dimensions shall be identical to the corresponding parts of standard bell and spigot fittings.
   4. A central fin not less than 1/2 inch thick and of the same diameter as a flange shall be cast on the barrel at a point that will locate it midway through the wall to form a waterstop.
   5. Alternate wall sleeve system as manufactured by Omni Sleeve, Malden, MA can be utilized as approved by Engineer, in place of above specified wall casting system.

PART 3 - EXECUTION

3.1 INSPECTION

A. Provide all labor necessary to assist the Engineer to inspect pipe, fittings, gaskets, and other materials.

B. Carefully inspect all materials at the time of delivery and just prior to installation.

C. Carefully inspect all pipe and fittings for:
   1. Defects, such as weak structural components, that adversely affect the execution and quality of work.
   2. Deviations beyond allowable tolerances for pipe clearances.

D. Immediately remove all rejected materials from the project site.

3.2 INSTALLATION

A. General:
   1. Install in strict accordance with the pipe and fitting manufacturer's instructions and recommendations and as specified or as shown on the Drawings.
   2. Acceptable thrust resistant system is required at all fittings on pressure pipe.

B. Assembling Joints:
   1. Flanged Joints:
      a. Insert the nuts and bolts (or studs), finger tighten, and progressively tighten diametrically opposite bolts uniformly around the flange to the proper tension.

b. Execute care when tightening joints to prevent undue strain upon valves, pumps, and other equipment.

2. Grooved Joints:
   a. Grooved joint shall be installed in accordance with the manufacturer's written recommendations.
   b. Grooved ends shall be clean and free from indentations, projections, or roll marks.
   c. The gasket shall be molded and produced by the coupling manufacturer of an elastomer suitable for the intended service.
   d. The coupling manufacturer's factory trained representative shall provide on-site training for the contractor's field personnel in the use of grooving tools and installation of product. The representative shall periodically visit the job site to ensure best practices in grooved product installation are being followed. (A distributor's representative is not considered qualified to conduct the training.)
3. Bolted Joints:
   a. Remove rust preventive coatings from machined surfaces prior to assembly.
   b. Thoroughly clean and carefully smooth all burrs and other defects from pipe ends, sockets, sleeves, housings and gaskets.
   c. All stainless steel fasteners for piping and supports shall be hand tightened to limit the potential for galling.

C. Fabrication:
1. Tapped Connections:
   a. Make all tapped connections as shown on the Drawings or as required by the Engineer.
   b. Make all connections watertight and of adequate strength to prevent pullout.
   c. Drill and tap normal to the longitudinal axis of the pipe.
   d. The maximum sizes of taps in pipes and fittings without busses shall not exceed the sizes listed in the appendix of ANSI A2l.5l based on 3 full threads for ductile iron.
   e. Taps in fittings shall be located where indicated by the manufacturer for that particular type of fitting.

D. Castings in Masonry:
1. Accurately set and align castings to be encased in masonry.
2. Thoroughly clean castings immediately prior to being set in place. Remove all rust, scale and other foreign material.

END OF SECTION

SECTION 15088

COUPLINGS & CONNECTORS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Furnish and install couplings and connectors of the type(s) and size(s) in the location(s) shown on the Drawings and as specified herein.

B. Related Work Specified Elsewhere: "Pipe & Pipe Fittings - General" is specified in this Division.

1.2 QUALITY ASSURANCE

A. Minimum pressure rating equal to that of the pipeline in which they are to be installed.

B. Couplings and connectors, other than those specified herein, are subject to the Engineer's approval.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All Couplings and Connectors:
   1. Gasket Materials: Composition suitable for exposure to the liquids to be contained within the pipes.
   2. Diameters to properly fit the specific types of pipes on which couplings and connectors are to be installed.

B. Sleeve Type Couplings (When Applicable):
   1. Exposed Couplings (When Applicable):
      a. Steel middle ring,
      b. Two steel follower rings,
      c. Two wedge-section gaskets,
      d. Sufficient steel bolts to properly compress the gaskets,
      e. Acceptable Manufacturers:
         i. Smith-Blair – Style 411
         ii. Romac – Style 400
         iii. Baker Hughes (GE Company) – Style 38
         iv. Or equal
   2. Buried Couplings (When Applicable):
      a. Cast iron or epoxy coated steel middle rings with pipe stops removed,
      b. Two malleable iron or epoxy coated steel follower rings with ribbed construction,
      c. Two wedge-section gaskets,
      d. Sufficient AWWA C-111 or galvanized steel nuts and bolts to properly compress the gaskets,

e. Acceptable Manufacturers:
   i. Smith Blair – Style 411
   ii. Romac – Style 501
   iii. Or equal.

C. Split Type Couplings (When Applicable):
1. Constructed from malleable or ductile iron.
2. For use with grooved or shouldered end pipe with minimum wall thickness as required so as not to weaken pipe.
3. Cast in two segments for 3/4 inch through l4 inch pipe sizes, four segments for 15 inch through 24 inch pipe sizes, and six segments for pipe sizes over 24 inch.
4. Coating: Enamel.
5. Bolts: Carbon steel.
6. All gaskets shall be Manufacturers Standard or as required for intended service with respect to fluid, temperature and pressure.
7. Acceptable Manufacturers:
   a. Victaulic Company of America, Style 77 for IPS Pipe, Style 31 for Ductile Iron Pipe.
   b. Star Pipe Products,
   c. Or equal.

D. Flanged Adapters (When Applicable):
1. For joining plain end or grooved end pipe to flanged pipes and fittings.
2. Adapters shall conform in size and bolt hole placement to ANSI standards for steel and/or cast iron flanges 125 or 150 pound standard unless otherwise required for connections.
3. Exposed Sleeve Type:
   a. Constructed from steel.
   b. Coating: Enamel.
   c. Bolts: Carbon steel or ASTM A588 steel.
   d. Acceptable Manufacturers:
      i. Dresser Manufacturing Co. - Style 128 for cast iron, ductile iron and steel pipes with diameters of 2 inches through 96 inches,
      ii. Smith Blair
      iii. Or equal.
4. Buried Sleeve Type:
   a. Constructed from cast iron.
   b. Bolts: ASTM A588 steel or galvanized steel.
   c. Acceptable Manufacturers:
      i. Dresser Manufacturing Co. - Style 127 locking type for cast iron, ductile iron, asbestos cement and steel pipes with diameters of 3 inches through l2 inches,
      ii. Smith Blair
      iii. Or equal.

5. Split Type:
    a. Constructed from malleable or ductile iron.
    b. For use with grooved or shouldered end pipe.
    c. Coating: Enamel.
    d. Acceptable Manufacturers:
        i. Victaulic Company of America - Style 741 for IPS pipe, or Style 341 for Ductile Iron Pipe, for pipe diameters of 2 inches through 12 inches,
        ii. Victaulic Company of America - Style 742 for IPS pipe, or Style 342 for Ductile Iron Pipe, for pipe diameters of 14 inches through 16 inches,
        iii. Star Pipe Products,
        iv. Or equal.

E. Flexible Joints:
1. Expansion Joints (Liquid Service):
    a. Materials shall be capable of withstanding the temperature, pressure and type of material in the pipeline.
    b. Shall be the filled arch type that will prevent sediment build up for all sludge, sewage, and other lines with similar service.
    c. Supplied with control rods to restrict elongation and compression.
    d. Metal retaining rings shall be split and beveled galvanized steel for placement against the flange of the expansion joint.
2. Expansion Joint (Air Service)
    a. Rubber expansion joints for all low pressure process air piping shall be of the non-filled arch double bellow type, unless otherwise noted.
    b. The expansion joint shall have ANSI 125-pound flanges.
    c. All low pressure process air piping rubber expansion couplings shall be capable of withstanding a pressure of 15 psig at a temperature of 250°F.
    d. Rubber expansion couplings shall be as manufactured by General Rubber Corp., Mercer Rubber Co., or equal.
3. Deflection Joints:
    a. Joints designed to permit a nominal maximum deflection of 15 degrees in all directions from the axis of the adjacent pipe length, will prevent pulling apart, and will remain watertight at any angle of deflection under 15 degrees.
    b. Material to be manufactured from a composition material suitable for exposure to the liquid, pressure and temperature to be contained within the pipe.
    c. Supplied with control rods as required.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Sleeve Type Couplings (When Applicable):
   1. Thoroughly clean pipe ends for a distance of 8 inches from the ends prior to installing couplings, and use soapy water as a gasket lubricant.
   2. Slip a follower ring and gasket (in that order) over each pipe and place the middle ring centered over the joint.
   3. Insert the other pipe length into the middle ring the proper distance.
   4. Press the gaskets and followers evenly and firmly into the middle ring flares.
   5. Insert the bolts, finger tighten and progressively tighten diametrically opposite nuts uniformly around the adapter with a torque wrench applying the torque recommended by the manufacturer.
   6. Insert and tighten the tapered threaded lock pins.
   7. Insert the nuts and bolts for the flange, finger tighten and progressively tighten diametrically opposite bolts uniformly around the flange to the torque recommended by the manufacturer.

B. Split Type Flange Adapters (When Applicable): Install in the same manner as Split Type Couplings.

C. Buried Cast Iron Couplings, Adapters and Connectors (When Applicable): Thoroughly coat all exterior surfaces, including nuts and bolts, after assembly and inspection by the Engineer with a heavy-bodied bituminous mastic as approved by the Engineer.

D. Buried Epoxy Coated Steel Couplings: Thoroughly coat all exterior surfaces, including nuts and bolts after assembly and inspection by the Engineer with a coal tar approved by the Engineer. Prior to coating, roughen the epoxy with emory paper and follow with a solvent cleaner (aeromatic similar to xylol). Dry film thickness of the coal tar is to be 12-16 mils.

E. Install thrust rods, supports, and other provisions to properly support pipe weight and axial equipment loads.

F. All interior sleeve type couplings shall be restrained with tie rods when used on pressurized lines. All buried couplings on pressure lines shall be restrained (solid sleeve) type.

END OF SECTION

SECTION 15092

PIPE SLEEVES & SEALS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Furnish and install wall sleeves and seals of the type(s) and sizes(s) and in the location(s) shown on the Drawings and specified herein.

B. Related Work Specified Elsewhere:

1. Pipe and Pipe Fittings - General is specified in Section 15050

1.2 QUALITY ASSURANCE

A. Provide and install all sleeves of the types specified herein, as shown on the Drawings and as directed by the Engineer.

B. Provide sleeves that are airtight, gastight or watertight as required.

PART 2 - PRODUCTS

2.1 TYPES AND LOCATIONS

A. General

1. Refer to details on Process Drawings.

B. Penetrations through New Construction:

1. Interior Masonry, Drywall, or Wood Partition (Non-Load Bearing) - Air to Air:
   a. 24 gauge, zinc coated (galvanized) steel tubes with wired or hemmed edges.
   b. Minimum 1/4 inch annular space between sleeve and pipe or insulation.
   c. Firmly pack with oakum and seal both ends with polyurethane sealant, per Section 07920 for standard penetrations.
   d. Install split cover plates in all finished areas. Both sides of wall if required. Plates shall be chrome finished, suitably sized to fit pipe in question and cover opening.
2. Exterior Masonry and Wood Walls
   a. Schedule 40 galvanized steel pipe, hot-dip galvanize after fabrication.
   b. Pipe sleeve thicknesses for sizes larger than 24-inch diameter shall be the standard 0.375-inch thickness.
   c. Minimum ¼-inch annular space between sleeve and pipe or insulation.
   d. Firmly pack with oakum and seal both ends with polyurethane sealant, per Section 07920 for standard penetrations.
3. Interior Concrete Partitions - Air to Air:
   a. Schedule 40 galvanized steel pipe with 1 inch x 1/8 inch thick welded sealing and anchoring collar in middle, hot-dip galvanize after fabrication. Pipe sleeve thicknesses for sizes larger than 24-inch diameter shall be the standard 0.375-inch thickness.
   b. Minimum 1/4 inch annular space between sleeve and pipe or insulation.

c. Firmly pack with oakum and seal both ends with polyurethane sealant, per Section 07920 for standard penetrations.
d. Refer to details on Process Drawings.

4. Concrete Floor Penetrations - Air to Air; and Air to Ground:
   a. Same as “Interior Concrete Partitions - Air to Air”.
   b. Pipe sleeve to extend 2 inches above finished floor.
   c. Pipe sleeve bottom to be set flush with underside of slab.
   d. Galvanized steel pipe riser clamp with threaded rod embedded into concrete floor to be installed on topside of penetration to support the pipe vertically.
   e. Refer to details on Process Drawings.
5. Roof Penetrations - Air to Air:
   a. Same as “Interior Concrete Partitions” and as shown on the Drawings.
6. Exterior Concrete Walls - Air to Air; and Air to Ground:
   a. Schedule 40 galvanized steel pipe with 1 inch x 1/4 inch integrally cast sealing and anchoring collar in middle, hot-dip galvanize after fabrication. Pipe sleeve thicknesses for sizes larger than 24-inch diameter shall be the standard 0.375-inch thickness.
   b. Size of pipe sleeve as required by seal manufacturer.
   c. Seal with rubber link compression seal.
   d. Alternate wall sleeve system as manufactured by Omni Sleeve, Malden, MA can be utilized as reviewed and accepted by Engineer, in place of above specified wall sleeve system.
   e. Refer to details on Process Drawings.
7. Concrete Tank Walls - Liquid Containing Structures to Air, Ground, or Liquid
   a. For ductile iron and steel piping systems, utilize wall castings, or sleeve and double rubber link compression seal. Materials, schedule, class and size to match pipe.
      i. For galvanized steel piping systems, use SCH 40 galvanized steel pipe with 1-inch x 1/4-inch welded sealing and anchoring collar in middle, hot-dip galvanized after fabrication. Pipe sleeve thicknesses for sizes larger than 24-inch diameter shall be the standard 0.375-inch thickness.
      ii. For stainless steel piping systems, use Schedule 40 stainless steel pipe with 1-inch x 1/4-inch welded sealing and anchoring collar in middle. Pipe sleeve thicknesses for sizes larger than 24-inch diameter shall be the standard 0.375-inch thickness.
      iii. For ductile or cast iron piping systems, use wall casting with 1-inch x 1/4-inch integrally cast sealing and anchoring collar in middle; or sleeve with 1-inch x 1/4-inch welded sealing and anchoring collar in middle, hot-dip galvanized after fabrication.
      iv. Refer to details on Process Drawings.
   b. For plastic piping systems, sleeve and seals to be in accordance with “Exterior Concrete Walls - Air to Ground” requirements noted above. These type penetrations will be allowable only in those locations specifically depicted on the drawings.

8. Foundation Walls Below Grade (Frost Walls) - Ground to Ground:
    a. Schedule 40 or max. 3/8 inch thick wall galvanized steel sleeve. Pipe sleeve thicknesses for sizes larger than 24-inch diameter shall be the standard 0.375-inch thickness.
    b. Minimum 1/2 inch annular space.
    c. Firmly pack with oakum and seal both ends with polyurethane sealant, per Section 07920 for standard penetrations.
9. Other conditions shall be sleeved or as reviewed and accepted by the Engineer.

C. Penetrations Through Existing Construction:
1. Interior masonry, drywall, or wood partition - Air to Air:
    a. Cleanly cut brick or block as required. Grout sleeve into place using non-shrink grout.
    b. Cleanly cut wood frames partitions as required. Set sleeve into position and secure.
    c. Sleeves to be as required for New Construction - Interior masonry, drywall, or wood partition - Air to Air.
    d. Holes bored with equipment leaving a smooth hole in masonry walls less than l/2 inch larger than the pipe will not require a sleeve, unless otherwise specified.
    e. Minimum 1/4 inch annular space between cored opening or sleeve and pipe or insulation.
    f. Firmly pack with oakum and seal both ends with polyurethane sealant, per Section 07920 for standard penetrations.
    g. Install split cover plates in all finished areas. Both sides of wall if required. Plates shall be chrome finished, suitably sized to fit pipe in question and cover opening.
2. Interior Concrete Partitions - Air to Air:
    a. Core smooth-walled opening with coring machine. Grout sleeve into place using non-shrink grout.
    b. Sleeves to be as required for “New Construction - Interior Concrete Partitions - Air to Air”.
    c. Holes cored with equipment leaving a smooth hole, less than l/2 inch larger than the pipe will not require a sleeve, unless otherwise specified.
    d. Minimum 1/4 inch annular space between cored opening or sleeve and pipe or insulation.
    e. Firmly pack with oakum and seal both ends with polyurethane sealant, per Section 07920 for standard penetrations.
3. Interior Concrete Partitions - Air to Air:
    a. Same as “Exterior Concrete Wall”.
4. Interior Concrete Partitions - Air to Air (Unclassified to Classified):
    a. Same as “Concrete Tank Wall”.
5. Exterior Masonry Walls
    a. Core drill a smooth hole through all layers of the existing masonry. Hole shall be sized to facilitate standard rubber link compression seal installation.
    b. Install rubber link compression seal at each layer of masonry.

c. Seal each face with polyurethane sealant.
d. If a clean, smooth hole cannot be achieved, remove the masonry as required to install Schedule 40 galvanized wall sleeve. Pipe sleeve thicknesses for sizes larger than 24-inch diameter shall be the standard 0.375-inch thickness. Grout sleeve in place. Install rubber link compression seal and sealant as noted above.

6. Exterior Wood Walls
   a. Remove existing siding and other materials, as required to install the new item.
   b. Restore the wall and siding to provide a weather-tight seal acceptable to the Engineer.
7. Concrete Floor Penetrations - Air to Air:
   a. Same as “Interior Concrete Partitions - Air to Air”, except that sleeve will not be required.
   b. Stainless steel pipe riser clamp with stainless steel threaded rod embedded into concrete floor to be installed on topside of penetration to support the pipe vertically.
   c. Install rubber link compression seal, as shown, covered by self-leveling sealant (SikaFlex or equivalent).
   d. Refer to details on Process Drawings.
8. Roof Penetrations - Air to Air:
   a. Same as “Interior Concrete Partitions - Air to Air” and as shown on the Drawings.
9. Concrete Exterior Walls - Air to Ground:
   a. Core smooth-walled opening with coring machine. Grout smooth any irregularities in opening.
   b. Size of cored opening as required by seal manufacturer.
   c. Seal with rubber link compression seal.
10. Concrete Tank Walls - Liquid Containing Structures to Air or Ground:
   a. Core smooth-walled opening with coring machine. Grout smooth any irregularities in opening.
   b. Size of cored opening as required by seal manufacturer.
   c. Seal with two, back to back rubber link compression seals.
11. Foundation Walls Below Grade (Frost Walls) - Ground to Ground:
   a. Core smooth-walled opening with coring machine. Grout sleeve into place using non-shrink grout.
   b. Sleeves to be as required for “New Construction - Foundation Walls Below Grade (Frost Walls) - Ground to Ground”.
   c. Holes cored with equipment leaving a smooth hole, less than 1-inch larger than the pipe will not require a sleeve, unless otherwise specified.
   d. Minimum 1/2 inch annular space between cored opening or sleeve and pipe or insulation.
   e. Firmly pack with oakum and seal both ends with polyurethane sealant, per Section 07920 for standard penetrations.
12. Other conditions shall be installed as reviewed and accepted by the Engineer.

D. Pipe openings in and penetrations through precast concrete structures shall be as specified in Division 2 and 3.

E. Rubber Link Compression Seals:
   1. Acceptable Manufacturers:
      a. Link Seal
      b. Flexicraft
      c. Or equivalent.
   2. Multi-rubber link type with pressure plates, bolts, nuts and sealing element providing a leak proof seal. Model numbers provided below are based on Link Seal and are to establish type and level of quality.
   3. General Service (Model C):
      a. Glass Reinforced Nylon Pressure Plate.
      b. Carbon steel zinc-dichromate nut and bolt.
      c. Sealing element: EPDM rubber.
      d. Temperature Rating: -40°F to 250°F.
   4. Corrosive Service: (Model S-316):
      a. Use in the following locations: Sludge tanks, scum tanks, digesters, wetwells, manholes, dewatering rooms, headworks rooms, exterior tanks, chemical rooms, as shown on the Drawings.
      b. Glass Reinforced Nylon Pressure Plate.
      c. Bolt and nut, l8-8 stainless steel.
      d. Sealing element: EPDM rubber.
      e. Temperature Rating: -40ºF to 250ºF.
   5. Potable/Clean Water Service (Model S61)
      a. Blue reinforced Nylon polymer pressure plates.
      b. 316 stainless steel nuts and bolts.
      c. Sealing element: Black EPDM NSF 61 certified.
      d. Temperature Rating: -40º to 250º F.
      e. Certified to NSF/ANSI standard 61.
   6. High Temperature Service (Model T)
      a. Steel zinc dichromate pressure plates.
      b. Carbon steel with zinc dichromate finish nuts and bolts.
      c. Sealing element: Silicone.
      d. Temperature Rating: -67º to 400º F.
   7. Refer to details on Process Drawings.

F. Wall Plates: Provide split type cast iron or brass wall plates on pipes penetrating walls in finished spaces such as labs and offices. Refer to details on Process Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. New construction:
   1. Concrete: Set sleeves in proper location prior to placing concrete. Sleeves set by mechanical, plumbing, and HVAC trades as appropriate.

2. Masonry: Mechanical, plumbing, and HVAC trades to provide sleeves and locations to masonry trades for installation.
3. Partitions: Set sleeves in place as work progresses.

B. Hollow Concrete Roof or Floor Planks:
1. Provide planks with sleeve cast-in-place at time of construction,
2. Or core drill planks in location reviewed and accepted by Engineer and plank manufacturer. Submit written approval of locations from pre-cast concrete plank manufacturer.
3. Firmly grout sleeve in place.

C. Existing Construction:
1. The location will be reviewed and accepted by the Engineer prior to coring or cutting hole.
2. For concrete, holes shall be located to avoid the reinforcing steel when possible.
3. Patch all damaged work as required to maintain a neat and clean appearance.

D. Rubber Link Compression Seals: Install as required and in strict accordance with the manufacturer's instructions and recommendations.

END OF SECTION

SECTION 15100

VALVES & SPECIALTIES – GENERAL

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Furnish, install, support, and test valves, gates, hydrants, cocks, stops, and faucets, when applicable, (hereinafter referred to as "valves") in the location(s) and of the size(s) and quantities shown on the Drawings and/or as specified herein.

B. Related Work Specified Elsewhere (When Applicable):
   1. Surface preparation and shop coatings are specified in Section 09905.
   2. Field painting is specified in Division 9.
   3. Pipe, fittings, pipe hangers and supports, and piping insulation are specified in the appropriate Sections in this Division.

1.2 QUALITY ASSURANCE

A. Provide valves of proven reliability manufactured by reputable manufacturers.

B. Acceptable manufacturers are listed in each section of this Division. Substitute or "or-equal" valves will be allowed only when indicated.

1.3 SUBMITTALS

A. Provide shop drawings in accordance with the requirements of the General Conditions, Section 01340 and as specified herein. Shop drawings shall contain the following information at a minimum:
   1. Completed Submittal Certification Form. Shop drawing submittals will be returned unreviewed without this form.
   2. Certified shop drawings.
   3. Manufacturer's literature and illustrations for all equipment to be installed to supplement certified shop drawing information.
   4. Short-term and long-term storage requirements.
   5. Seismic analysis, design and calculations as specified herein.
   6. Shop preparation and shop coatings.
   7. Proposed valve identification tag information

B. Provide Operation and Maintenance Manuals in accordance with the requirements of Section 01340.

1.4 DELIVERY AND HANDLING

A. Shipping:
   1. Prepare valves and accessories for shipment as required for complete protection.
   2. Seal valve ends to prevent entry of foreign matter into valve body.
   3. Box, crate, completely enclose, and protect valves and accessories from accumulations of foreign matter.

B. Storage:
   1. Store valves and accessories in an area on the construction site protected from weather, moisture, or possible damage.
   2. Do not store valves or accessories directly on the ground.

C. Handling: Handle valves and accessories to prevent damage of any nature to the interior and the exterior surfaces.

1.5 INSPECTION

A. Carefully inspect all materials for:
   1. Defects in workmanship and materials.
   2. Removal of debris and foreign material in valve openings and seats.
   3. Proper functioning of all operating mechanisms.
   4. Tightness of all nuts and bolts.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials are specified in appropriate Sections in this Division.

B. The specifications direct attention to certain required features of the valves and gates but do not purport to cover all details entering into their design and construction. Nevertheless, the Contractor shall furnish the valves and gates complete in all details and ready for operation for the intended purpose.

2.2 SURFACE PREPARATION AND SHOP COATINGS

A. Provide surface preparation and shop coatings in accordance with the applicable section of Division 9.

2.3 VALVE ACTUATORS

A. Unless otherwise specified or shown on the Drawings, all valves shall be manually actuated. All valves shall have an operating handwheel or a handle/lever mounted on the operator or extension stems as indicated on the Drawings. Valves with operating nuts shall be of non-rising stem design and be provided with an AWWA 2 inch square operating nut. The valves shall be provided with handwheel actuators on all manually actuated valves larger than 6 inches in size unless otherwise specified or shown on the Drawings.

B. The valve Manufacturer shall supply and factory mount all actuators; including any type of manual or powered actuators. The valves and actuators shall be shipped as a single unit. All valve actuators shall be sized to operate the associated valve for the full range of pressures and velocities. Position indicators shall be provided for interior NRS valves.

C. The force in a manual actuator shall not exceed 40 pounds of rim-pull under any operating condition, including initial breakaway. The actuator shall be equipped with gear reduction when force exceeds 40 pounds of rim-pull. All manual actuators shall be self-locking type or shall be equipped with a self-locking device. The actuators shall be capable of moving the valves from a fully open to a fully closed position and a fully closed position to a fully open position. The actuator shall be

capable of holding the valve at any position in between the fully open and fully closed positions. A position indicator shall be supplied on quarter-turn valves. Each actuating device shall have the word "OPEN" permanently cast as well as an arrow indicating the direction of operation.

D. Unless otherwise specified or shown on the Drawings chainwheel actuators shall be provided for all valves 3 inches and larger; with the valve center line located 6 feet or greater above the operating floor. All chainwheel actuators shall be provided complete with chain guides and hot dipped galvanized or cadmium-plated steel chain. The chain shall loop within a minimum of four (4) feet from the operating floor level. Where chains hang in normally traveled areas, appropriate "L" type tie-back anchors shall be used.

E. All chainwheel actuators of the same type, style, and duty shall be supplied by a single Manufacturer. Where applicable and whenever possible, chainwheel actuators shall be provided by the Manufacturer of the valve being served.

2.4 VALVE IDENTIFICATION TAGS

A. All valves in piping including individual valves provided with equipment shall be tagged in accordance with that shown on the Drawings. The tags shall be provided with identifying numbers and letters to match those shown on the Drawings. Identification tag numbering shall be reviewed/confirmed with the Engineer and Owner through the submittal process prior to ordering any tags. Refer to Section 11000 for additional information regarding valve tagging.

B. All identification tags shall be provided with sufficient lengths of chain for attachment to the respective valve.

C. Tags shall conform to the following specifications:

1. The tags shall be 2.5-inch diameter, 1/16" thick, rigid, multi-layered sandwich laminate with contrasting inner and outer colored acrylic plastic layers. Top hole size is 5/32" for hanging tags.
2. Tags shall be available in 7 different outside colors. Owner and Engineer shall select up to 4 different colors for the project.
3. Tags shall have up to three lines engraved on a side and eight characters per line of identification information. Tags shall be engraved one side.
4. Tags shall be secured to valves with nylon cable ties or adjustable metal bead chain. Securing method shall be selected by the Owner and Engineer.
5. Tags secured to equipment shall be fastened to a flat visible surface by a minimum of two SS screws or SS pop rivets.
6. Tags shall have a service temperature of -40°F to 175°F
7. Manufactured by Seton Name Plate Corporation, New Haven, CT, Brimar Industries, Garfield, NJ or equal.

D. All buried valves shall be provided with tags embedded in a concrete pad surrounding the valve box.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install valves and accessories in strict accordance with manufacturer's instructions and recommendations, as shown on the Drawings and/or as specified herein. Install valves with stems pointed up in vertical position, or horizontally on high valve for chain wheel use, but in no case with stems pointed downward of the horizontal plane. Allow sufficient room for maintenance, removal and proper operation. All valves shall be located and oriented to permit easy access to the valve operator, and to avoid interferences.

B. Valve Orientation: The stem of a manual valve shall be installed in a vertical position when the valve is installed in horizontal runs of pipe having centerline elevations of 4.5 feet or less above finished floor, unless otherwise shown on Contract Drawings. The stem of a manual valve shall be installed in a horizontal position in horizontal runs of pipe having centerline elevations between 4.5 feet and 6 feet above the finish floor, unless otherwise shown on Contract Drawings. All manually actuated valves 3 inches and smaller shall have the valve indicators and operators located to display toward the normal operational locations.

C. Carefully erect all valves and support them in their respective positions free from distortion and strain.

D. Independently support all valves connected to pumps and equipment, and in piping systems that cannot support valves.

E. Repair any scratches, marks and other types of surface damage etc. with original coating as supplied by the factory.

F. Install valves such that "open" and "close" position indicators are easily visible.

G. All valves (and actuators where specified) shall be installed in a manner that will provide for proper clearances and ease of operation. In addition, valve actuators must be capable of being rotated in 90° increments to facilitate field installation.

H. Check and adjust all valves and accessories for smooth operation.

3.2 TESTING

A. The Contractor shall test all valves and gates in the presence of the Engineer to demonstrate that each valve and gate complies with specified requirements and allowable leakage rates.

B. The contractor shall test all valves visually for leaks and proper operation under pressure. The contractor shall also test the valves to ensure proper valve function and actuation.

C. Valves may either be tested while testing pipelines, or as a separate step. It shall be demonstrated that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, and in both directions for two-way valve applications. The Contractor shall count and record the number of turns required to open and close each valve and account for any discrepancies with the Manufacturer's data.

D. Air and vacuum relief valves shall be examined as the associated pipe is being filled to verify venting and seating is fully functional. The Contractor shall set, verify, and record set pressures for all relief and regulating valves. Self-contained automatic valves shall be tested at both maximum and minimum operating ranges,

and reset upon completion of test to the design value.

E. The contractor shall take care not to overpressure any valve and appurtenances during testing.

3.3 RETESTING

A. If the equipment does not successfully pass the tests listed above, the Manufacturer/Contractor shall repair the equipment and perform the tests again until passing the tests successfully. If any deficiencies are revealed during any test, such deficiencies shall be corrected, and the tests shall be re-conducted at no additional cost to the Owner.

3.4 CLEANING

A. All items, including but not limited to all valves and valve interiors, shall be thoroughly cleaned prior to installation, testing, and final acceptance. All dirt, debris, and other foreign materials shall be removed.

3.5 FIELD COATINGS

A. In accordance with Section 09900.

END OF SECTION

SECTION 15101

GATE VALVES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Furnish, install and test gate valves of the type(s) and size(s) and in the location(s) shown on the Drawings and as specified.

B. Related Work Specified Elsewhere: "Valves and Specialties - General" is specified in this Division.

1.2 QUALITY ASSURANCE

A. All gate valves of same type and style shall be manufactured by one manufacturer.

B. Acceptable Manufacturers: as noted herein.

PART 2 - - PRODUCTS

2.1 VALVE, LOCATION AND USE

A. As shown on the Drawings.

B. Water Supply Piping:

1. Buried: AWWA Type, NRS.
2. Exposed: AWWA OS&Y, or NRS as required.

C. General Service Piping (liquids containing solids):

1. Includes plant water, and liquids containing solids.
2. 2-l/2 inches and smaller: l25 bronze.
3. 3 inches and larger: Non-rising stem; resilient wedge.

D. Accessories: As shown on the Drawings and required for proper operation.

2.2 MATERIALS

A. Waterworks type NRS valves (AWWA):

1. Valve Body, bonnet and stuffing box - Cast iron (ASTM A126, C1B), or Ductile iron (ASTM A536), coated inside and out with fusion bonded epoxy meeting AWWA C550. Face-to-face dimensions shall comply with ANSI B16.10 and flanges to comply with ANSI B16.1.
2. Resilient Wedge - Ductile iron wedge with bonded EPDM or Nitrile (Buna-N/NBR) rubber covering.
3. Stem - Manganese bronze, ASTM B584
4. Stuffing box O-rings
   a. Two O-rings, each nitrile rubber.
   b. Capable of changing under pressure.
5. Wedgenut - Bronze, ASTM B62 or Manganese bronze, ASTM B584
6. Bolting - stainless steel Type 18-8 (304 SS), ASTM F593, GP1
7. End Connections
   a. Buried valves – gasketed and bolted mechanical joints in conformance with AWWA standards for appropriate pipe material.

b. Exposed valves – flanged and bolted joints in conformance with ANSI/ASME B16.1 and AWWA standards for appropriate pipe material. Bolts shall be stainless steel.

8. Operation
   a. Buried valves – 2-inch square nut, cast iron, ASTM A126, C1B or ductile iron, ASTM A536
   b. Exposed valves - Handwheel, cast iron or cast aluminum with direction arrow.
   c. Opening Direction –clockwise (open right)
9. Standards - valves shall meet or exceed AWWA C509, latest edition.
10. Manufacturer
    a. American Flow Control
    b. Kennedy/McWane
    c. Clow/McWane
    d. Mueller
    e. Or equal

B. Waterworks type OS&Y valves (AWWA):
   1. Equal in all respects to non-rising stem valve specified above, except as required for OS&Y operation.

C. General Service - 2-l/2 inch and smaller:
   1. Bronze construction - l25 pound stem.
   2. Union bonnet.
   3. Inside screw, rising stem.
   4. Solid disc, taper wedge.
   5. End connections:
      a. Threaded.
      b. Or solder ends for copper pipe systems.
   6. 200 psi non-shock WOG.
   7. Malleable iron, or steel handwheel.
   8. Acceptable Manufacturers:
      a. Stockham B-l05.
      b. Craine 428-UB.
      c. Powell 2700S.
      d. Jenkins 47U.
      e. Kennedy/McWane 525.
      f. Or approved equal.

D. General Service NRS - 3 inches and larger:
   1. Wedge shall be constructed of ductile iron, fully encapsulated in synthetic rubber, except for guide and wedge nut areas.
   2. Non-rising stem (NRS).
   3. Bolted bonnet (stainless steel Type 18-8, ASTM F593, GP1 bolts and nuts).
   4. 125 class body.
   5. Meet or exceed AWWA C-509.
   6. All valves shall be fitted with a resilient wedge.
   7. Flanged ends: 125 pound drilling, ANSI B16.1.
   8. Face to Face dimensions: ANSI B16.1.

9. Water working pressure:
   a. 12 inches and smaller: 200 psi.
   b. 14 inches and larger: l50 psi.
10. End Connections
   a. Buried valves – gasketed and bolted mechanical joints in conformance with AWWA standards for appropriate pipe material.
   b. Exposed valves – flanged and bolted joints in conformance with ANSI/ASME B16.1 and AWWA standards for appropriate pipe material. Bolts shall be stainless steel.
11. Operation:
   a. Buried valves – 2-inch square nut, cast iron, ASTM A126, C1B or ductile iron, ASTM A536
   b. Exposed valves - Handwheel, cast iron or cast aluminum with direction arrow; except when 2 inch square operating nut when shaft extension, floor box, valve box or floor stand is required or shown on the Drawings.
   c. Opening Direction – clockwise (open right)
12. Buried Valves:
   a. All mechanical joint gate valves shall meet ANSI/AWWA C110/A21.10 and ANSI/AWWA C111/A21.11.
   b. Mechanical joint type coated inside and out with fusion bonded epoxy meeting AWWA C550.
   c. 2-inch square operating nut, securely fastened to shaft.
   d. Gate box required.
   e. Sufficient quantity of tee-handle valve wrenches for operating valves of various depths.
   f. Opening Direction – clockwise (open right)
13. Acceptable Manufacturers:
   a. American Flow Control
   b. Kennedy/McWane
   c. Clow/McWane
   d. Mueller
   e. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and test in accordance with Section 15100, AWWA C500 and AWWA C-509, latest revision.

B. For horizontal piping, install valves with stem position between horizontal to vertical upward.

END OF SECTION

SECTION 15110

CHECK VALVES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Furnish and install check valves of the type(s) and size(s) and in the location(s) shown on the Drawings and as specified herein.

B. Related Work Specified Elsewhere: "Valves & Specialties - General" is specified in this Division.

C. Requirements Specified Elsewhere: Additional requirements that affect the work of this Section are specified elsewhere including, but not limited to General Conditions, Supplementary Conditions and:

1. Section 01340 - Submittals
2. Section 01400 - Quality Control
3. Section 01800 - Equipment Startup, Certification and Operator Training
4. Section 09905 - Surface Preparation and Shop Coatings

The General Contractor is responsible for conveying the appropriate information from these sections to the supplier.

D. Related Work:

1. Field painting is specified in Section 09900.
2. Section 15100 – Valves & Specialties - General

1.2 QUALITY ASSURANCE

A. All check valves of same type and duty shall be by one manufacturer.

B. All valves in contact with potable water shall be constructed of “Lead free” material in compliance with NSF 372 (formerly NSF 61 Annex G and Safe Drinking Water Act Section 1417). Lead free materials shall contain less than 0.25% lead on a weighted average, and installed using flux and solder containing not more than 0.2% lead.

C. Interior coatings shall be NSF-61 certified for contact with potable water.

PART 2 - PRODUCTS

2.1 SWING TYPE CHECK VALVES – 3 INCH AND LARGER – GENERAL USE

A. The check valve shall conform to the materials of construction, pressure rating and test requirements of AWWA C508 and be suitable for installation in a horizontal or vertical flow up pipe.

B. The body shall be made of cast iron conforming to ASTM A126 Class B with a bolted steel cover allowing complete access to and removal of all internal components while the valve is in the line.

C. The valve body shall have integral flanges, flat faced and drilled per ANSI B16.1 Class 125 or Class 250, as required.

D. The valve body shall have a removable Type 316 stainless steel body seat held in place with stainless steel pins.

E. The disc arm shall be ductile iron and the disc shall be cast iron with a replaceable Buna-N (or other suitable material) disc seat held in place by a type 316 stainless steel follower ring and stainless steel screws. The disc shall be attached to the disc arm by means of a center pin, disc nut and washer providing 360 degree angular articulation but not rotation.

F. The disc arm shall be suspended from and keyed to a stainless steel shaft that is supported at each end by stainless steel or no-lead bronze bushings. The shaft shall rotate freely without the need for external lubrication. The shaft shall be sealed where it passes through the body by means of a stuffing box and adjustable packing.

G. Bosses shall be provided on check valves which may be tapped for draining or used for by-pass. The inside and outside of all valves together with the working parts, except bronze and machined surfaces, shall be coated in accordance with AWWA C-550.

H. Marking shall be in accordance with AWWA C-508 and shall include size, working pressure, and cast arrow to indicate direction of flow, name of manufacturer, and year of manufacture.

I. The valve shall be supplied with an outside lever and adjustable counterweight. The lever and weight shall be on the right hand side of the valve (looking in the direction of flow) but shall be field convertible to the left hand side without additional parts. Fitted with an adjustable dashpot or snubber to control speed of valve closure.

J. The valve shall also be provided with a single, side mounted air-cushion assembly directly mounted to the valve body. The amount of cushioning shall be adjustable without the need for pre-charged air chambers.

K. Acceptable Manufacturers:
   1. Val-Matic Series 7800LW
   2. GA Industries Figure 220
   3. Or equal

PART 3 - EXECUTION

3.1 INSTALLATION

A. In accordance with Section 15100.

B. Install check valves in horizontal sections of pipeline unless otherwise indicated on the Drawings.

END OF SECTION

SECTION 15444

NATURAL GAS SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Furnish and install a natural gas system within the generator enclosure to a point outside the enclosure in the location of the new gas meter, including final connection to the meter.

B. Related Work Specified Elsewhere: "Plumbing - General" is specified in Section 15400, "Steel Pipe & Fittings" is specified in Section 15061.

1.2 QUALITY ASSURANCE

A. The entire installation shall conform to NFPA54 as amended by the State of New Hampshire.

B. Installation, testing, and replacement of gas piping, appliances, or accessories, and repair and servicing of equipment, shall be performed only be a qualified agency.

1.3 SUBMITTALS TO THE ENGINEER

A. General: Submittals shall be in accordance with specification Section 01340.

B. When state or local codes require licensed gas fitters or licensed plumbers to perform the work being done on the natural gas system, submit notarized copies of licenses of all mechanics to be used on the installation.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver gas system materials to job site as work progress requires.

B. Protect all materials in a suitable weathertight enclosure to prevent damage of any nature.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials shall be in accordance with NFPA54 and all state and local codes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Clean pipe before installation.
2. Remove internal scale.
3. Ream pipe ends after cutting.
4. For screwed joints, apply noncorrosive, non-hardening Teflon pipe thread compound or Teflon tape to male threads only.
5. Install gas piping and accessories according to NFPA No. 54.

6. Install gas piping parallel with building walls or structure. The lower end of all vertical supply piping near equipment shall terminate with a tee, nipple and cap to serve as a sediment trap.
7. Install a gas cock and union in the pipe adjacent to each appliance, in such a manner that the appliance may be removed without disturbing the gas piping.

B. Gas Service: Tie into new gas company gas meter.

C. Gas pipe sizes are based on the terminal equipment designed around. The Contractor shall confirm line sized based on NFPA54 sizing criteria for the terminal equipment provided on the job prior to the start of the installation.

D. Leak testing shall be in accordance with NFPA54 requirements. Test pressure shall be 1 ½ times working pressure. Test duration shall be not less than ½ hour for each 500 ft^3 of pipe volume. Piping system shall withstand the test pressure without showing any evidence of leakage.

E. Purging: After piping has been tested, the Contractor shall fully purge the gas piping in accordance with NFPA54.

END OF SECTION

SECTION 16000

ELECTRICAL - PUMP STATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide all labor, materials, equipment, operations, methods and procedures as specifically noted herein these specifications and as indicated in the Contract Documents, together with all items necessary for or incidental to the completion of the work.

B. All systems or additions to existing systems indicated in the Contract Documents shall mean all necessary supervision, labor, equipment and materials required to provide complete, properly functioning systems.

C. All systems shall be adjusted, tested, inspected and turned over to the Owner in perfect working order.

D. The words "provide", "supply", "supply and install", "install", "furnish" or "furnish and install", as used in DIVISION 16 or as indicated on the Drawings related to DIVISION 16 shall mean a complete and properly functioning Electrical installation performed by the Contractor.

E. References:

1. Refer to each individual drawing within the Contract Documents in order to coordinate material and equipment locations and electrical requirements.
2. Applicable portions of DIVISION 0 and DIVISION 1 are part of DIVISION 16. Refer to these sections for additional information on bidding requirements, general requirements, Section 01800 for equipment start-up, and product substitution.

F. Work Specified Herein:

1. Visit and examine the project site and become familiar with all existing conditions pertinent to the work to be performed thereon. No additional compensation will be allowed for failure to be so informed.
2. The following scope of work is a brief generalization of the type and extent of the work specified under DIVISION 16. Detailed requirements are indicated on the Drawings and in related sections of the Specifications. The work includes, but is not necessarily limited to the following:
    a. Provide Electrical Service and Distribution System as indicated on the "Single-Line Diagram", related drawings and schedules, and as specified herein.
    b. Installation of new service to pump station backboard.
    c. Installation of outdoor generator
    d. Installation of pumps and instrumentation at the wetwell.
    e. Installation of site lighting
    f. Contractor shall be responsible for obtaining temporary power to conduct work as required. Temporary power may be obtained from the local power company or by a temporary generator as required in order to maintain continuous operation of the pump station during the schedule of the

construction period. The generator and all required fuel are to be supplied by the electrical contractor.

G. Make all required connections to the pumping station and for the electric service.

H. Removals and Relocations:

1. Examine the existing site, structure(s) and installation(s) for the work of all trades which will influence the cost of the work under DIVISION 16. This work shall include removals and relocations relating to the work of all trades which may interfere with, disturb or complicate the performance of the work under DIVISION 16; and relating to the work involving systems, equipment and related service lines which shall continue to be utilized as part of the finished project.
2. Provide all associated labor, material and costs to include all removals, relocations, and reconnections herein specified, necessary or required to provide operation and coordination of the combined new and existing systems and equipment.
3. Demolition:
    a. Disconnect and remove existing equipment, devices, boxes, conduit, and associated electrical equipment as shown on the contract drawings.
    b. Any demolition or relocation work performed which results in unused openings in control panels, instrument panels, control stations, pull or junction boxes, etc., which are to remain, shall be plugged by appropriate means such that it maintains the integrity of the NEMA classification of the area, as defined on Drawing E-1.
    c. Any demolition or relocation which results in unused openings shall be sealed.
    d. The work of this Contract involves demolition work. Review all Contract Documents and coordinate with all disciplines for a complete understanding of this demolition work. Provide all new work required to modify these changes along with all requirements for installation of the new work, as shown on the Contract Drawings.
    e. Disconnect and remove all abandoned conduits, wiring, boxes, equipment, controls, hangers, etc., shown or not shown, which are located within the area of construction under this contract.

I. Request for Information:

1. When there is a conflict or coordination issue, or if additional information is necessary for the contractor to proceed with the intended work, a Request of Information (RFI) form shall be submitted through the General Contractor to the Engineer. The specific issue shall be described in the RFI and shall be sent to the engineer for review and a response provided in an appropriate time period. RFI form shall be available via the General Contractor through the Engineer. This process shall be used as part of the work of this contract. Products FURNISHED but not installed under this section.

J. Bid Allowance:

1. A bid allowance has been established for estimated cost by the power company for the work required by them under this contract. Refer to General Conditions and Bid Forms including Measurement and Payment for exact requirements and costs to be carried as part of the work required under this section. Actual

amounts shall be invoiced and submitted by the respective utility company for payment with any credits for this allowance will be returned to the Owner under this contract.

K. Bid Alternates:
   1. Refer to DIVISION 1 of the Contract Drawings for all work related to Bid Alternates for this project. Bid Alternates have been identified and described for specific work areas and equipment. The Contractor shall determine all associated work and costs required for these items for a complete system.
   2. The drawings indicate and define areas where work related to the bid alternates under this section is required. This has been noted and shown as clearly as possible. However, it does not show each and every possible component for these bid alternates. Therefore, it shall be the contractor's responsibility to include all associated materials, labor and costs associated with the required bid alternatives for a complete system.
   3. Reference Section 01100 for additional requirements

1.2 QUALITY ASSURANCE

A. In general, the workmanship of the electrical installation shall be as described in the N.E.C.A. Electrical Design Guidelines. All methods of construction, details of workmanship, etc., that are not specifically described therein or indicated in the Contract Documents, shall be subject to the control and no exceptions to the Engineer.
B. Equipment and materials shall be of the quality and manufacture indicated in their respective description within the specifications.
C. Work determined by the Engineer to be unsatisfactory according to industry standards shall be redone at the Contractor's expense, with no additional compensation.
D. Safety and care of equipment and electrical installations to remain the responsibility of the subcontractor until final acceptance by owner. Any cost associated due to damages or loss prior to owner acceptance to be covered by subcontractor.

1.3 SUBMITTALS TO THE ENGINEER

A. Submit Shop Drawings, O&M Documentation, and manufacturer certificates in accordance with Section 1340 The requirements below are in addition to the standards therein.
B. Submittals required under this section include, but are not limited to the following for each of the locations specified:
   1. Conduit
   2. Wiring and Cables
   3. Service distribution equipment
   4. Main circuit breaker
   5. Meter socket
   6. Lightning arrestor and line surge protection
   7. Receptacles
   8. Automatic transfer switch
   9. Mounting hardware and materials
   10. Lighting fixtures and switches

11. Electrical distribution equipment
12. Miscellaneous electrical equipment
13. Pullboxes
14. Control station push buttons and enclosures
15. Expansion fittings
16. Motor starting equipment as required for the installation
17. VFD parameter settings, VFD software and digital copy of parameters
18. Conduit seal fittings
19. Emergency Standby Systems and Equipment
20. Equipment test results
21. Conduit Layout Plans
22. Megger test results for cables and equipment prior to putting equipment into service
23. Submit all other equipment as required by the Contract

C. Operations and Maintenance Manual
   1. Requirements
      a. Provide a complete bill of material for each piece of equipment.
      b. Provide a preventative maintenance section for all applicable equipment including recommended schedule and spare parts.
      c. Panels which require customized schematics shall be updated with changes made in the field and submitted on 11" x 17" size drawings. Also internal and front elevation drawings shall be included identifying all equipment.
      d. All equipment shall include a troubleshooting section with common symptoms and recommended solutions.
      e. All equipment shall include emergency operations instructions particularly to Emergency Generators and Automatic Transfer Switches on how to operate the equipment when the automatic function of the equipment fails.

D. Submittals:
   1. Shop Drawings Shall Consist Of:
      a. Project name and location.
      b. Contractor's name.
      c. Index Sheet - Listing the equipment being submitted utilizing equipment designations, or symbols, indicated on the Contract Documents together with the proposed manufacturer, style/ type and catalog number.
      d. Manufacturer's scale or dimensioned drawings along with standard catalog "cut" sheets.
      e. Equipment ratings, service clearances and configuration.
      f. Listing of accessories to be furnished.
      g. Single-line and schematic diagrams where applicable.
      h. Refer to related sections of the specifications for special shop drawing requirements for individual equipment types.
   2. Provide samples of such items as lighting fixtures and wiring devices upon request of the Engineer.
   3. Standard manufacturer's catalog cut sheets are acceptable; however, they shall be modified to indicate equipment and options to be provided for this project.

Any listed equipment, options, or features which are not to be provided shall be properly indicated in the submittal. Failure to properly indicate project-specific equipment, options, and features will result in the submittal being returned without being reviewed.

4. Submit test results as listed in Section 3.4

1.4 PRODUCT HANDLING

A. All materials shall be shipped, stored, handled and installed in such a manner as not to degrade quality, serviceability, or appearance.

B. Electrical equipment shall at all times during construction be adequately protected against mechanical injury or damage by water. Electrical equipment shall not be stored out of doors. Electrical equipment shall be stored in dry permanent shelters. If any apparatus has been damaged, such damage shall be repaired at no additional cost. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and put through such special tests as directed by the Engineer, or shall be replaced at no additional cost to the Owner.

1.5 DESIGN CRITERIA

A. Service and Metering

1. The power company serving this project is Eversource. The service representative this project is as follows:
   Contact Person: Casey McDonald
   Contact telephone number: 603-519-0924
   Work Order: 128-081-01

2. Service will be obtained at 120/240V, 60 Hertz, from a pole-mounted service transformer located at the site, as shown on the drawings. The existing service riser pole is to be upgraded by the power company.
3. Extend new secondary service conduit and wires from the existing service riser pole and service transformer to the new generator building as shown on the drawings. Installation of conduits and supports per local utility requirements. Provide number and size of conduits per local utility requirements.
4. Furnish and install the meter socket per power company requirements.
5. Coordinate all shutdowns and activations of the services with the power company as part of this work.
6. Make all arrangements with the power company for obtaining service and pay all charges and furnish all labor and material for the service. An allowance has been established for this work. Refer to General Conditions for these specifications for specific bid allowance to be carried as part of the work of this contract.
7. Provide all service disconnections and re-energizations required by the Power Company during the work of this contract and include these costs as part of the work of this contract as part of the allowance establish for this electrical service work.

B. Communication Services

1. The communications company service provider the town is Comcast. The electrical contractor is to coordinate with the town and the service provider to

relocate the overhead fiber optic lines and telephone lines on the service pole as necessary for the construction of the pumps station.

2. This work has been covered as part of a bid allowance.

C. Codes, Inspection and Fees

1. All material and installation shall be in accordance with the latest edition of the National Electrical Code and the codes and ordinances of the Town or City of which the work is being performed.
2. Pay all fees required for permits and inspections. All power utilization fees incurred prior to owner's acceptance to be paid by subcontractor.

D. Tests and Settings

1. Test all systems furnished under DIVISION 16, ELECTRICAL and repair or replace all defective work.

PART 2 - PRODUCTS

2.1 GENERAL

A. Materials and equipment used shall be Underwriters Laboratories, Inc. listed.

B. Refer to Drawing E-1 for specific references to NEMA ratings for equipment specified unless otherwise noted.

2.2 RACEWAYS AND FITTINGS

A. Rigid steel conduit shall be hot dipped galvanized as manufactured by Republic Steel Corp., Allied Tube and Conduit Corp., Wheeling Pittsburg Steel Corp., or equal.

B. Conduit hubs shall be as manufactured by Myers Electric Products, Inc., Raco Div., Appleton Electric Co., or equal.

C. PVC coated rigid steel conduit as manufactured by Rob-Roy "Plasti-Bond", Ocal, or equal.

D. PVC Schedule 80 shall be extra heavy wall and UL Listed for the use intended. Acceptable Manufacturers: Carlon, Rob-Roy, or equal.

E. Aluminum conduit shall be rigid, heavy wall aluminum. Acceptable manufacturers: Anaconda, Kaiser, VAW, or equal.

F. Flexible Metal Conduit

1. Flexible Metal Conduit shall be constructed of one continuous length of U. L. Approved electro-galvanized, spirally wound steel strip with interlocking convolutions and interior surfaces free from burrs and sharp edges.
2. Flexible metal conduit shall be "liquid-tight" with PVC jacket. Acceptable Manufacturers: Alflex - a division of Southwire, Electri-Flex, Thomas & Betts - a division of ABB, or equivalent.
3. Flexible metal conduit installed in hazardous, NEMA 7, Class I Div 1 areas shall be UL Listed, and shall have a bronze or stainless-steel braid covering over a flexible brass inner core. Packing shall be woven cotton braid impregnated with asphalt. Acceptable manufacturer: Crouse-Hinds - a division of Eaton, Killark, Thomas & Betts - a division of ABB -XP Series, or equal.

2.3 WIRES AND CABLE

A. Wires and cables shall be of annealed, 98 percent conductivity, soft drawn copper. All conductors installed below grade shall be XHHW stranded. All conductors #8 and larger shall be XHHW.

B. Power wiring shall be 600V, Type XHHW. Type XHHW shall be cross linked polyethylene, as manufactured by Pirelli Cable Corp., Collyer Insulated Wire Company, The Okonite Company, or equal.
C. Control wiring shall be 600V, Type THHW/THHN No. 14 AWG stranded. Type THHW/THWN shall be cross linked polyethylene, as manufactured by the Pirelli Cable Corp., Collyer Insulated Wire Company, The Okonite Company or equal.
D. Signal wiring shall be 600V, individual shielded twisted pair, No. 16 AWG stranded with polyethylene jacket. Provide Belden Catalog No. 8719, Alpha Wire & Cable, or equal.
E. Ground wires shall be THW and color-coded green.
F. Variable frequency drive (VFD) motor supply cables shall be provided where indicated on Drawings. VFD cables shall be four (4) conductor tinned stranded copper, with cross-linked polyethylene insulation, overall foil (100% coverage) / tinned copper braid (85% coverage) shields, No. 12 AWG tinned copper drain wire, and outer PVC jacket. Cables shall conform to UL specification for 1000 Volt flexible motor supply cable. Acceptable Manufacturers: Belden, Olflex, or equal.
G. Ethernet wiring shall be Category 6, 4-pair 24 AWG solid bare copper conductor, unshielded, FEP insulated, plenum rated. Acceptable manufacturers shall be Belden, Omni, or equal.
H. Wire markers shall be "OMNI GRIP" as manufactured by W.H. Brady Company, or equal.
I. All wires and cables specified and installed underground shall be U.L. Listed and Labeled for underground use for all installations.

2.4 METERING SOCKET AND METERING CABINET

A. Meter socket shall be of the type as recommended by the power company.
B. Acceptable manufactures are Milbank, Square D, or equal.

2.5 AUTOMATIC TRANSFER SWITCH

A. GENERAL
1. The automatic transfer switch shall be designed for an emergency and normal source with ratings as indicated on the drawings. The automatic transfer switch shall be as manufactured by Cummins, Caterpillar, Russell Electric, or equal and shall be provided by the generator manufacturer under Specification Section 16620.
2. The transfer switch manufacturer shall have been regularly engaged in the production of UL (Underwriters Laboratory) Standard 1008 Listed transfer switches. The transfer switches shall be documented, and have been offered for sale on the open market for a minimum of five (5) years. The manufacturer shall provide factory trained parts and service support through a factory authorized distributor that is regularly doing business in the area of the installation.
3. The manufacturer shall supply literature containing diagrams, parts lists and descriptions sufficient for the owner's personnel, or subcontract supplier to install, operate and perform normal maintenance on the equipment.
4. Testing: To provide proven reliability of the system, transfer switches shall be completely tested as follows:

a. Representative production samples of the transfer switches supplied, shall be demonstrable, through tests, the ability to withstand at least 10,000 mechanical operating cycles. An operating cycle shall consist of one (1) electrically operated transfer from normal to emergency and back to normal.

b. During the development of the original transfer switching mechanism for this family of transfer switches, a prototype of the transfer switching mechanism shall have passed the environmental tests listed in Military Standard, Mil-Std-202E. These tests shall include Method 101D-Condition B, Salt Spray-Corrosion; Method 103B-Condition B, Humidity; Method 107D-Condition A, Thermal Shock; Method 110A Sand and Dust.

c. Transfer switches shall be UL Listed per Standard 1008. The minimum WCR (Withstand and Closing Current Ratings) shall meet the requirements of UL Standard 1008 and shall be obtained without contact welding. Where the line side overcurrent protection is provided by circuit breakers at 480 volts AC or less, the short circuit WCR shall be as follows:

TRANSFER SWITCH CONTINUOUS CURRENT RATINGS	K & J/L FUSES	WITHSTAND AND CLOSING RATINGS
40A, 70A, 100A	125A/200A*	14,000A RMS
150A, 260A	400A/600A*	30,000A RMS
400A, 600A	1200A/1200A*	65,000A RMS
800A, 1000A	2000A/2000A*	65,000A RMS

* Class J and L Fuses WCR = 200,000A RMS

i. The RMS (root Mean Square) symmetrical fault current ratings shall be verified by UL witnessed tests on representative test samples. All WCR tests shall be performed with the overcurrent protective devices located external to the transfer switch. Tests conducted with overcurrent protective devices internal to the transfer switch, in such a manner that the transfer switch interrupts the current rather than withstanding the current, are not acceptable under this definition of withstand.

ii. Where the line side overcurrent protection is provided by current-limiting fuses, the fuses shall be UL Class RK1, RK5, J, or L (with the fuse sizes being no larger than the UL. listed maximum ratings or component recognition procedures for the transfer switches supplied). The transfer switch closing rating shall be suitable for 200,000A available fault current, as verified by UL witnessed tests on representative test samples.

d. Provide testing as specified herein.

5. Ratings: All transfer switches shall be UL Listed per Standard 1008. All transfer switches shall be suitable for use on emergency and legally required standby systems in accordance with ANSI-C1 and NFPA-99, rated for total system load. These loads shall include motors, electric discharge lamps,

resistive loads, and tungsten lamps as described in Section 1 of UL 1008 Standard.

6. Transfer switches shall be 60 HZ. Refer to drawings for the number and locations of transfer switches, number of phases, number of poles, voltage, and ampere ratings.
7. Transfer switches shall be rated to carry 100 percent of their rated current continuously when in an enclosure. Refer to enclosure requirements as shown on the Drawings for each specific project location. Transfer switches which must be derated when installed in an enclosure (due to integral overcurrent devices or any other reasons) do not meet this specification. Transfer switches shall be rated for continuous operation in ambient temperatures of -40° C (-40°F) to 67°C (142°F).
8. Construction: Transfer switches shall be over center operation, double-throw construction, center neutral position type positively electrically and mechanically interlocked by a simple mechanical beam to prevent simultaneous closing (for break before make operation), and mechanically held in both normal and emergency positions.
    a. Transfer switches shall be quick-break, quick-make operation so that the speed of opening and closing is not controlled by an operator during manual operation. Transfer switches shall be a center neutral position type switch and shall provide a center "Programmed Transition" position for manual switching.
    b. Transfer switches shall be approved for manual operation under full load by integral mounted, permanently attached, high dielectric, manual operating handles. Manual operating handles, which are normally stored and must be installed for manual operation, do not meet this specification.
    c. The electrical operating means shall be a direct-acting, center neutral position, constant force in both directions, bi-directional linear induction motor to provide minimum friction, straight-line switch action. Motor shall be attached directly to the switching mechanism without the use of gears, cams, or other complex mechanical linkage methods.
    d. Transfer switches shall not contain any integral overcurrent devices in the main power circuit, including molded case circuit breakers or fuses.
    e. The transfer switch electrical actuator shall have an independent disconnect means to disable the electrical operation during manual switching.
    f. Manual operating handles and controls (other than key-operated switches) shall be accessible to authorized personnel only by opening the keylocking cabinet door. Transfer switches located on the outside of the cabinet do not meet this specification.

    g. Unless noted or specified otherwise, each transfer switch shall be mounted in separate cabinet enclosures with key-locking front doors and no mechanical clips or fasteners located around the outside of the enclosure door as specified herein.
    h. Maximum transfer time in either direction shall be six (6) cycles, except where the "Programmed Transition" feature is furnished.

i. All transfer switches shall have transparent protective covers to protect operating personnel during manual operation, and to allow an operator to visually determine that the main contacts are "Open" or "Closed".

j. The main switch contacts shall be of the no maintenance type and high pressure silver cadmium oxide to resist burning and pitting for long life operation. All switches shall have arc chutes of heat absorbing material and metal leaves for positive extinguishing of arcs quickly and effectively; arc chutes shall have insulating covers to prevent interphase flashover.

k. Transfer switches shall have one (1) S.P.D.T. (Single Pole Double Throw), auxiliary dry switch contacts on both the normal and emergency-sides, operated by the transfer switch. These auxiliary switch contacts shall be factory wired to an easy access terminal block and may be used to monitor transfer switch position for controlling indicator lamps or other peripheral equipment. Contacts shall be rated 1200 VA.

l. Complete AL-CU (Aluminum-Copper) lugs, UL listed and CSA certified, shall be provided for both normal and emergency load positions. Provide all required lugs/phase for each switch based on cable sizes shown on the Contract Drawings. For 150A and larger transfer switches, top or bottom feed for load connections shall be provided for slimmer design, requiring less wall space. Load connections shall be field changeable either from top-to-bottom or bottom-to-top. Wiring space at normal, emergency, and load lugs inside the transfer switch cabinet shall comply with the latest edition of NEC. Full rated neutral bar with lugs for normal, emergency, and load neutral conductors shall be provided inside the cabinet.

m. Relay, with 2 N.O. and 2 N.C. contacts, which is energized whenever the normal source is available regardless of switch position.

n. Relay with 2 N.O. and 2 N.C. contacts, which is energized whenever the emergency source is available regardless of switch position.

9. Controls: Control accessories, either electronic or relay, shall be mounted in a separate smaller cabinet mounted on the inside of the main cabinet door. This is to allow for ease of service when the main cabinet lockable door is opened, but to prevent access by unauthorized personnel. Controls shall be microprocessor based type with operator interface panel for monitoring, viewing and setting of system parameters.

   a. Control circuit disconnect plugs shall be provided to reenergize control circuits to avoid the hazards of electrical shock to personnel while making adjustments.

   b. The Power Sentry electronic control, undervoltage and time delay modules, shall be a printed circuit board for ease of service. The solid-state undervoltage sensors shall simultaneously monitor all phases of the normal and emergency power sources to provide field adjustable range sensors for specific applications.

      i. Voltage pickup settings shall be adjustable from a minimum of 85% to a maximum of 100% of nominal voltage. Voltage dropout settings shall be adjustable from a minimum of 74% to a maximum of 98% of the pickup setting with a fixed dropout time delay of 0.5 second.

ii. Voltage sensors shall be of the temperature compensated type, for maximum deviation over the temperature range of -32°C (-25°F) to 79°C (175°F). Voltage sensors shall allow for adjustment to sense partial loss of voltage on any phase of the normal or emergency power source, even where motor feedback voltages exist.

iii. Provide phase failure (loss of any phase) phase unbalance and phase rotation type sensing for protection of all phases of the system.

c. The Overvoltage and Frequency Sensing control, overvoltage and frequency sensing module, shall be a printed circuit board for ease of service. The solid-state overvoltage sensor(s) shall simultaneously monitor all phases of the source(s) to provide field adjustable ranges of voltage pickup and dropout and time delays. Frequency sensor(s) shall simultaneously monitor all phases of the source(s) to provide field adjustable ranges of frequency pickup and dropout and time delays.

i. Under/over frequency and over voltage sensing for the emergency source.

d. Controls shall signal the emergency power system to start upon signal from normal source voltage sensors. Solid-state adjustable time delay (0-90 sec) start shall avoid nuisance engine¬-generator set start-ups on momentary voltage dips or interruptions. Initial setting shall be 5 seconds.

e. The transfer switch shall transfer the load to the emergency power system after the engine-generator set reaches proper voltage and frequency and has stabilized.

f. The transfer switch shall control the engine-generator set to allow the set to start and transfer the load within 10 seconds (adjustable from 2 to 120 sec) after a normal source power failure. It shall be the responsibility of the transfer switch supplier to meet this requirement.

g. The transfer switch shall retransfer the load to the normal source after normal source power is restored, allowing normal source to stabilize before retransfer and shall allow staggered retransfer of loads in multiple transfer switch systems. Retransfer time delay shall be adjustable from 0-30 min. Initial setting shall be 3 minutes.

h. The controls shall signal the engine-generator set(s) to stop after load retransfer to the normal source but shall maintain the availability of the emergency source in the event that the normal source fails shortly after retransfer. The controls shall allow the engine-generator set(s) to run unloaded for a cooldown period prior to shut down (adjustable from 0 to 10 min). Initial setting shall be 5 minutes.

i. The controls shall provide an automatic retransfer of the load from the emergency source to the normal source if the emergency source fails when the normal source is available.

j. The transfer switch operating power for transfer and retransfer shall be obtained from the source to which the load is being transferred.

k. Controls shall provide built-in "Control Mode Status" indicators, mounted on the interior of the enclosure, consisting of L.E.D.s (Light Emitting Diodes) to indicate a sequence of functions such as the following:

i. Source 1 OK

ii. 2-Wire Run
iii. Source 2 Ok
iv. Timing for Transfer
v. Transfer Command
vi. Timing for Retransfer
vii. Retransfer Command
viii. Timing for Stop

l. The indicators shall allow the operator to determine that the controls are properly sequencing and shall assist in determining the sequence of any malfunctions that might occur.

m. Main cabinet front door mounted controls and indicator lamps shall consist of oil-tight, neon position indicator lamps (NORMAL - White and EMERGENCY - Amber) and key-operated Test and Selector switches to provide the following functions:
   i. TEST - Simulated normal source power loss to control unit for testing engine-generator set capability. Provide selector switch inside cabinet to allow for choice of load transfer or test without transfer.
   ii. NORMAL - Normal operating position and also restores the system to stand by operation; and if load was transferred, retransfers load from emergency to normal source after test and time delays.
   iii. RETRANSFER - Spring-loaded momentary position of switch, that overrides retransfer time delay to cause the immediate return to the normal source after a test or actual power outage.

n. Transfer switch shall be provided as a delayed transition, center neutral position switch. This feature shall be provided to allow for delay residual voltage of connected load. The time delay shall occur during switching in both directions, during which time the load is isolated from both normal and emergency sources. This will allow residual voltage components of motors or other inductive loads (such as transformers) to decay before completing the switching cycle.

o. The center neutral, delayed transition shall be connected in a manner that will not cause the time delay in switching, where the time delay has already been established by the loss of voltage to the load during normal source power interruptions.

10. Switches shall be equipped with the following items:
   a. Provide microprocessor based controller and Exerciser clock to set day-of-week (one week dial minimum), time-of-day, and duration-of-time of engine-generator set(s) exercise. A period with/without load selector switch.
   b. Provide Manual-Automatic retransfer selector switch. After normal source is restored, this switch provides either manual or automatic retransfer after the retransfer time delay has expired in the automatic position, or manual retransfer at a time selected by an operator.
   c. Frequency reading of 45-65 HZ.
   d. Generator running time meter reading in hours.

e. Multi-position AC readings and phase selection to read line current and line-to-line and line-to-neutral voltages in each phase with off position.
f. Meter(s) shall read whichever source is connected to the load.

2.6 MAIN CIRCUIT BREAKER

A. Circuit breaker shall be molded case, 600 Volts, sized as indicated on the Drawings with not less than 22,000Amperes, RMS interrupting capacity. Circuit breaker shall be installed within an enclosure with neutral and ground lug kit factory installed and provided in the enclosure. The operating handle shall be side mounted and pad lockable in the "On" and "Off" position. The breaker should still provide overload and short circuit protection when locked in the "ON" position.
B. Circuit breaker shall be UL listed and labeled as being suitable for use as service entrance equipment.
C. Acceptable manufacturers are Square D, Cutler Hammer, or equal.

2.7 GROUND ROD

A. 10 foot long by 3/4 inch diameter copper clad steel ground rods shall be provided, arranged and installed as shown on the drawings. Provide all required Cadwelds, grounding clamps and hardware as required for a complete installation per NEC and as shown on the drawings.
B. Acceptable manufacturers are Erico, AB Chance Co., or equal.

2.8 EXOTHERMIC CONNECTION

A. The contractor shall be responsible to furnish and install exothermic connections as required and shown on the contract drawings.
B. The mold shall be new and clean and shall provide all required connection molds for different required types.
C. All connections shall be industry standards in a complete, continuous, and properly installed connection. Any connections not properly installed as inspected shall be removed and re-formed at the contractor's expense.

2.9 LIGHTNING AND SURGE PROTECTION

A. Lightning and surge protection units shall be Square D Model Number SDSA 1175, single phase for 250 VAC phase-to-ground voltage. Provide a separate unit at all locations shown on the drawings. Provide a spare lightning and surge protection unit to the Owner for spare parts.

2.10 WIRING DEVICES

A. Receptacles shall be duplex, 20 Ampere, industrial grade and shall be ground fault type. Outdoor receptacles shall be provided with weatherproof, while in use type covers.
B. Light switches shall be rated 20 Ampere, single pole type.
C. Duplex receptacles shall be duplex, 20 ampere, industrial grade type.
D. Covers shall be stainless steel gasketed for exposed or concealed inside locations and weatherproof while in use covers for outdoor locations.
E. Acceptable manufacturers are Cooper, Hubbell, or equal.

2.11 POWER DISTRIBUTION PANEL PDP

A. Provide power distribution panel board with bolt-on breakers and copper busses. Panelboard shall be rated as shown on the drawings, but not less than 22,000 Amperes RMS Symmetrical. Panel board shall be provided as shown and noted on the contract drawings. Acceptable manufactures are Square D, Cutler Hammer, or General Electric, or equal.

B. Submit complete documentation for coordination, short circuit, and arc flash study and report immediately upon approval of equipment and prior to start-up and testing of any equipment. Submit reports prior to release of equipment in order to make any necessary changes based on the study's findings before the equipment is approved. No start-up will be allowed without this study and report and without the final recommended system settings being implemented and tested in the field. If equipment needs to be ordered prior to receiving the study, all necessary changes will be the responsibility of the contractor at no additional costs.

2.12 LIGHT FIXTURES

A. Two floodlights of the same model will be required to be stanchion mounted, the product code for this light is VFS-K-B40-7-LED-E1-WST the stanchion mount accessory is a requirement. This is a 400 LED system operating at 700mA

B. Acceptable manufactures are Cooper Lighting, Holophane, or equal.

2.13 EXPANSION FITTINGS

A. Expansion fittings shall be watertight expansion type, designed to compensate for conduit movement. Expansion fittings shall be provided to allow movement of 4 inches in both directions for a total of 8 inches. Fittings shall have flexible copper braid bonding jumpers, neoprene sleeve and stainless-steel bands. Acceptable Manufacturer: O.Z./Gedney Type EX, Thomas & Betts, or equal.

2.14 PULLBOXES AND JUNCTION BOXES

A. Junction boxes shall be cast malleable iron or aluminum type and gasketed type FS series with hubs unl.

B. Pullboxes other than explosion proof shall be seamless weld type, galvanized with flush type screw-on covers and no hinges or side clamps all around. Use Myers hubs for conduit termination and entry into pullboxes. Acceptable manufactures are Rittal, Hoffman, or equal.

C. Instrumentation junctions are to be 304 stainless steel. Refer to contract drawings for additional information.

D. Explosion-proof pullboxes shall be NEMA 4/7, Class I, Division 1, Group C & D or NEMA 4/7, Class I, Division 2, Group C and D for hazardous rated areas. Provide conduit sealing fittings inside and outside of explosion proof areas for all conduits per NEC. Acceptable manufactures are Appleton, Crouse Hinds, or equal.

E. Boxes for concealed work shall be used only for concealed installations.

2.15 MOUNTING SUPPORTS AND HARDWARE

A. Provide aluminum or 304 stainless steel metal channel and 4" channel angle supports and mounting plates as shown and required for equipment mounting. All legs for stanchion mounting structures shall be channel angle support, no exceptions.

B. All bolts, washers and mounting hardware shall also be 316 stainless steel for the entire installation.
C. Acceptable manufactures are B-Line Systems, Inc., Thomas & Betts-Super Strut, Unistrut, or equal.

2.16 LINK SEAL

A. Furnish and install link seal fittings at all areas of buildings and structures both above and below grade for conduit entry. Refer to the contract drawings for additional requirements.
B. Acceptable manufactures are Innerlynx, Crouse Hinds, or equal.

2.17 MOTOR CONNECTIONS

A. Provide all required flexible conduit liquid tight or explosion proof to meet the NEMA rating as noted on the drawings. Limit lengths to 24" or less. Moved to cable section.

2.18 RELAYS

A. Industrial Control Relays - Relays provided with 10 Ampere contact rating shall be Square D, Class 8501 type X or equal. Relays with 30 Ampere contact rating shall be Square D, Class 8501, type C or equal.
B. Pilot Duty Relays - General purpose relays shall be IDEC RH Series, 10A contact rating, 4 Form "C" contacts or equal, provided with internal indicating light. Pilot duty control isolating relays for PLC inputs and outputs shall be suitable for the application and shall be submitted with no exceptions by Engineer.
C. Relays shall be electrically operated with 120 Volt coils except as noted otherwise on the Drawings. Contacts shall be rated 600 Volt, 10 Ampere.

D. Interposing relays used for telemetry inputs or other low current inputs shall be Potter and Brumfield type KHAU-17A16 - 120 Volt, or equal.
E. Timing Relays:
    1. Delay timing relays shall be general purpose, solid state type rated for use at 120 Volts. Contacts shall be rated 5 Amperes (minimum). Minimum time range shall be adjustable from 1 second to 1 minute. Time delay relays shall be IDEC RTE or equal.

2.19 TERMINAL STRIPS

A. Terminal strips shall be supplied to make all power and control connections. All terminals shall be numbered and clearly marked for easy identification. Acceptable manufacturers are Allen Bradley, Phoenix Contact, or Equal.

2.20 WIRE IDENTIFICATION

A. All individual conductors shall be identified using unique numerical tags corresponding to conductor designations indicated on approved shop drawings of schematic diagrams for all terminations. This includes all process- and non-process-related wiring done as part of the work, such as fire alarm panels. Conductors shall be clearly identified at each terminal block, equipment connection and junction. Markings shall utilize the equipment designation and terminal block number in the device higher upstream in the system hierarchy.

B. For Conductors No. 6 and smaller, color coding shall correspond to the color of the conductor insulation. For color coding of wire larger than No. 6, use self-adhesive, wrap-around type markers. These markers shall be used at all panelboards, junction boxes, disconnect switches, circuit breakers, etc.

2.21 CONTROL DEVICES

A. Selector switches shall be removable from the front of the panel without disturbing the wiring or mounting of the control unit. Selector switch shall be bat wing type, 30mm in size.
B. Indicator lights shall be 30 mm, Push-to-Test, heavy duty, oiltight with LED lamps and designed to operate at 120 Volts, 60 Hz AC. Indicator lights shall be provided with mounting rings, engraved as indicated on the Drawings. Lens color shall be as indicated.
C. All equipment and devices shall be rated for space where being installed.
D. Acceptable manufactures are Allen Bradley, Square D, or Cutler Hammer, equal.

2.22 CONTROL POWER TRANSFORMERS

A. Supply all control power transformers necessary to make panel functional. All transformers shall have both primary legs and all "hot" secondary legs fused. One secondary leg shall be grounded.
B. Acceptable manufacturers are Square D, Siemens, or equal.

2.23 CONTROL CIRCUIT FUSES

A. Fuses shall be rated for at least 125 Volts at the current ratings shown on the Drawings.
B. Fuses shall be Littlefuse, Bussmann, or equal.

2.24 CONDUIT SEALS

A. Provide Class I, Div. 1, Groups C & D conduit seals as required by the N.E.C. and as shown on the Drawings or required by the NEC.
B. Provide Class I, Div. 2, Groups C & D conduit seals as required by the N.E.C. and as shown on the Drawings or required by the NEC.
C. Acceptable manufacturers: Appleton, Killark, O-Z/Gedney, or equal.

2.25 VARIABLE FREQUENCY DRIVE CONTROL PANEL

A. Furnish and install a variable frequency drive (VFD) control panel for the submersible pump. VFD control panel shall be installed in a vented painted steel dead front enclosure with the following equipment:
    1. Schneider Altivar 630 VFD equipment, no equal.
    2. (2) 10 HP, Variable Torque VFDs, 3% Line Reactor , EMI Filter
    3. Single wall-mounted enclosure with all associated equipment located within this panel which shall operate the respective sewage pump. No separately mounted devices outside this panel will be acceptable.
    4. Through the door disconnect switch.
    5. Front panel mounted keypad.
    6. The application shall provide for a 240 volt single phase input under normal and emergency electrical service to the VFD control panel and covert to a 240

volt three phase output. The sewage pump is rated 5 HP at 460 volt 3 phase with the following parameters:

a. Full Load Current = 10 Ampere
b. Maximum Full Load Current at Service Factor = 11.5 Ampere
c. Locked Rotor Current = 62 Ampere

7. Refer to contract drawings for specific requirements and number of VFD units required.
8. Provide control devices as shown on the schematic diagrams. Refer to controls within this section.
9. Provide all programming and setup for the VFD. Provide VFD Parameter Setup and Verification.

B. Provide a complete and operational VFD control panel for the submersible pump motor.
C. Provide a total of one (1) day of startup for the VFD equipment after confirmation of pre-startup has been completed. Reference Section 01800 for coordination of startup requirements.
D. Provide 1 day of separate training.
E. Refer to drawings for wiring requirements.

2.26 CABLE SEALS

A. Conduit sealing bushings to seal the ends of conduits entering enclosures from below grade shall be OZ Gedney Co., Type CSB Series or equal.

2.27 ATENNA MAST

A. Provide a 1-1/2" aluminum antenna mast with a weather head. Mast to be installed 10 feet above finished floor. Antenna will be provided and installed by the owner.

2.28 FINAL AS-BUILT RECORD DRAWINGS

A. During the ongoing construction the contractor shall maintain a clean set of full size drawings for markup. The drawings shall be red lined and marked up with all appropriately noted changes noting the as-built condition. Upon completion of the project the set of as-built markups shall be provided to the Engineer for final AutoCAD revisions.

2.29 COMPLETE ELECTRICAL DISTRIBUTION EQUIPMENT SUPPLIER

A. All electrical distribution equipment submitted for this project shall be by a single equipment manufacturer. Multiple suppliers of this equipment shall not be acceptable. The following manufactures shall be acceptable:
1. Square D Company
2. Cutler-Hammer
3. Siemens
4. GE(ABB)

2.30 TEMPORARY POWER REQUIREMENT USING PORTABLE GENERATOR

A. The use of a portable generator for temporary power must meet the dBA requirements of the respective city or town where the work is to be performed when in use during all periods of operation.
B. All permits required for this application shall be the complete responsibility of the

contractor.

PART 3 - INSTALLATION

3.1 RACEWAYS AND FITTINGS

A. Unless otherwise indicated on the Drawings, install all wiring in the following applicable raceway system:
   1. Wiring 600 volts or less in outdoor locations (NEMA 3R or 4X): Galvanized rigid heavy wall steel conduit or aluminum conduit.
   2. Wiring 600 volts or less in hazardous locations (NEMA 7 or 9): PVC coated galvanized rigid steel conduit.
   3. Underground Raceways
      a. Electrical Service: Underground raceways shall be Schedule 40 heavy wall PVC conduit. Concrete encase duct bank.
      b. All conduits to the pump station are to be rigid galvanized steel.
      c. Duct banks to the wet well and generator are to be sand encased.

B. Where conduit extends out from underground or enters a structure/building or utility pole, it shall be installed as galvanized rigid steel conduit within 10’ of the structure. This shall remain galvanized rigid steel to its final destination.

C. Where conduits are installed concealed within or below concrete slab and extend up through the slab with PVC coated galvanized rigid steel conduit sweeps and shall remain galvanized rigid steel conduit for all exposed areas.

D. No wire shall be pulled until the raceway system is complete in all details.

E. The ends of all raceways shall be tightly capped to exclude dust and moisture during the construction period. Caps shall be of a UL Listed type specifically used for this purpose. Rags, papers, etc. shall not be used.

F. Raceways terminating in gasketed enclosures shall be terminated with conduit hubs.

G. Raceways installed underground shall be encased in concrete and laid on trenches on mats of bank gravel or sand not less than six inch thick and well graded.

H. Provide long radius rigid steel conduit sweeps at entrances to equipment from underground.

I. Provide conduit expansion fittings as required. Install per manufacturers recommendation.

3.2 WIRES AND CABLES

A. All conductors shall be carefully handled to avoid kinks or damage to insulation.

B. Alarm wires shall be uniquely identified at each end with wire markers. A typed list of the numbers used and their function (alarm served) shall be submitted to the Engineer by the Contractor.

C. After installation of service conductors seal conduits in pump station with duct seal.

D. Grouping of Conductors
   1. Contractor may group certain wiring with the approval of the Engineer, as follows.
      a. Power 120V may be grouped with power 120V
      b. Control 120V may be grouped with control 120V
      c. Control 24V may be grouped with control 24V
      d. Instrumentation may be grouped with instrumentation
      e. Specialty wiring may be grouped with like systems

f. Power wiring at 240V shall not be grouped
g. Fire alarm system wiring shall not be grouped with other systems

The installation shall be installed in accordance with all requirements of the NEC (including wire ampacity derating factors), manufacturer's requirements, and the Engineer. Excessive grouping which interferes with functionality and reliability will not be allowed. The wiring configuration as shown on the drawings is the baseline requirement for the work.

3.3 GROUNDING

A. Provide grounding conductors from ground electrodes to equipment as shown on the Drawings.
B. Do not use conduit as the ground and/or bonding conductor.
C. Bond ground terminal of receptacles to outlet boxes with #l2 AWG green insulated wire.
D. Ground conduit system and neutral conductor of wiring system with a connection at the main electrical service breaker.
E. The grounding network shall be connected to metallic water piping system, at two or more locations, with stranded copper, AWG, Green Insulated Conductor of the same size as grounding electrode conductor shown on the drawings or required by the National Electrical Code (NEC).
F. Make connections to ground rods with an exothermic welding process. Mechanical connections may be made at equipment only.
G. Ensure that a ground loop is not formed between equipment ground in electrical conduit and grounding electrode conductors directly connected to ground electrodes.
H. Group and bond ground wires to panel boxes, light fixtures, receptacles, etc., not to system neutral.
I. Make connection to water pipe with a suitable ground clamp or lug connection. If flanged pipes are encountered, make connection with lug bolted to flange connections.
J. Bond and ground all conduit systems.

3.4 EQUIPMENT

A. The inside of all equipment and enclosures shall be checked for tools and vacuumed cleaned of any debris.
B. The Contractor shall be responsible to ensure that all connections to motors, distribution equipment, and control panels are tightened to manufactures recommendations.

3.5 TESTS

A. The entire grounding network resistance to be meggered and certified results recorded and submitted with no exceptions to the Engineer. Resistance shall not exceed 25 Ohms.
B. Branch circuits shall be tested during installation for continuity and identification and shall pass operational tests to determine that all circuits perform the function for which they are designed.
C. Adjust all settings on protective equipment and verify, check and establish with the power company that the secondary voltage is within 2% of rated voltage.

D. Test and set all motor circuit protectors, motor overload heaters to the nameplate horsepower of the equipment; and all circuit breaker settings in all electrical equipment shall be tested and verified operational.

E. Three phase panelboard's line currents shall be balanced to within 10% of each other.

F. For all feeder wiring rated 600 volts or less, provide 1,000 volt "Megger" insulation test prior to energizing feeders. Use a motor-driven megger for all tests. Test voltage shall be applied until readings reach a constant value, and until three (3) equal readings, each one (1) minute apart, are obtained. Minimum megger reading shall be 45 megohms for feeder conductors. Document test results and submit to engineer. There shall be no exceptions taken by the Engineer before conductors are to be energized. See attached table at end of this section for recording data and submission to the Engineer.

G. Three phase motors shall be checked for rotation and, if necessary, reverse the connections at the starter. Single phase and DC motors at motor connection box.

H. VFD START UP, TESTING AND VERIFICATION

1. Responsibility and Coordination: The VFD manufacture, supplier and electrical subcontractor are responsible for adjusting all of the VFD parameters for a fully functional system integrated with the instrumentation and control systems for this project. The VFD supplier and electrical subcontractor are responsible for coordinating with the instrumentation subcontractor and the instrumentation programmer so the control systems function as intended as described in the instrumentation control descriptions.
2. VFD Parameter Setup: Complete the VFD Parameter Setup Checklist and Verification below in the presence of the specifying engineer.
3. The electrical subcontractor shall be responsible to coordinate an onsite meeting with the VFD manufacturers technician and the specifying engineer. This meeting shall take place prior to the initial startup of the equipment.

VFD PARAMETER SETUP CHECKLIST

[ENTER NAME OF FACILITY]

- ☐ 1. Ramp up speed _____
- ☐ 2. Ramp down speed _____
- ☐ 3. Min speed (Hz) _____
- ☐ 4. Max speed (Hz) _____
- ☐ 5. 4-20mA setting at min speed (mA) _____
- ☐ 6. 4-20mA setting at max speed (mA) _____
- ☐ 7. Output scale calibration _____
- ☐ 8. Auto restart after power failure (yes/no) _____
- ☐ 9. Auto restart after overcurrent fault (yes/no) _____
- ☐ 10. Speed reference (internal/external) _____
- ☐ 11. If external - signal source _____
- ☐ 12. If external - signal type _____
- ☐ 13. Restart after E-Stop (yes/no) _____
- ☐ 14. Discrete outputs - Run (yes/no) _____
- ☐ 15. Discrete outputs - Fault (yes/no) _____
- ☐ 16. Analog outputs - Amps (absolute units) _____
- ☐ 17. Analog outputs - KW (absolute units) _____
- ☐ 18. Analog outputs - Speed (Hz) _____
- ☐ 19. Analog outputs - Speed (RPM) _____
- ☐ 20. Analog inputs - 4mA set to 0Hz (yes/no) _____
- ☐ 21. Analog inputs - 20mA set to 60Hz (yes/no) _____
- ☐ 22. Analog inputs - min speed limit set (yes/no) _____
- ☐ 23. Analog inputs - max speed limit set (yes/no) _____
- ☐ 24. Voltage boost (%) _____
- ☐ 25. Starting frequency (Hz) _____
- ☐ 26. PMW carrier frequency (Hz) _____
- ☐ 27. Acceleration time (sec) _____
- ☐ 28. Deceleration time (sec) _____
- ☐ 29. Forward run (yes/no) _____
- ☐ 30. Reverse run (yes/no) _____
- ☐ 31. Overload (60%-100%) _____

VFD PARAMETER SETUP VERIFICATION

[ENTER NAME OF FACILITY]

Date: _____

General Contractor: _____

Electrical Subcontractor: _____

VFD Supplier: _____

This certifies that the VFD parameters have been coordinated per the specifications and the requirements of this section.

_____ _____
(Authorized Representative of the General Contractor) Date

_____ _____
(Authorized Representative of the Electrical Subcontractor) Date

_____ _____
(Authorized Representative of the VFD Supplier) Date

PUMP STATION "NAME"
MEGGER TEST RESULTS

Project: _____ **Temperature:** _____
Date: _____ **Weather:** _____
Location: _____ **Test Equipment:** _____

Equipment / Feeder Under Test: _____ **Start Time:** _____ **End Time:** _____

Test Equipment: Make: _____ **Serial No.:** _____ **Test Voltage:** _____

	0.5 min	1 min	2 min	3 min	4 min	5 min	6 min	7 min	8 min	9 min	10 min	P.I.
ΦA-Gnd.												
ΦB-Gnd.												
ΦC-Gnd.												
ΦA-ΦB												
ΦA-ΦC												
ΦB-ΦC.												

Equipment / Feeder Under Test: _____ **Start Time:** _____ **End Time:** _____

	0.5 min	1 min	2 min	3 min	4 min	5 min	6 min	7 min	8 min	9 min	10 min	P.I.
ΦA-Gnd.												
ΦB-Gnd.												
ΦC-Gnd.												
NEUT -Gnd.												
ΦA-ΦB												
ΦA-ΦC												
ΦB-ΦC.												

Notes: *Megger test only should record 5 minute value*
Polarization Index (P.I.) is 10 min reading divided by 1 min reading

END OF SECTION

VFD PARAMETER SETUP VERIFICATION

[ENTER NAME OF FACILITY]

Date: _____

General Contractor: _____

Electrical Subcontractor: _____

VFD Supplier: _____

This certifies that the VFD parameters have been coordinated per the specifications and the requirements of this section.

_____ _____
(Authorized Representative of the General Contractor) Date

_____ _____
(Authorized Representative of the Electrical Subcontractor) Date

_____ _____
(Authorized Representative of the VFD Supplier) Date

PUMP STATION "NAME"
MEGGER TEST RESULTS

Project: _____ **Temperature:** _____
Date: _____ **Weather:** _____
Location: _____ **Test Equipment:** _____

Equipment / Feeder Under Test: _____ **Start Time:** _____ **End Time:** _____

Test Equipment: Make: _____ **Serial No.:** _____ **Test Voltage:** _____

	0.5 min	1 min	2 min	3 min	4 min	5 min	6 min	7 min	8 min	9 min	10 min	P.I.
ΦA-Gnd.												
ΦB-Gnd.												
ΦC-Gnd.												
ΦA-ΦB												
ΦA-ΦC												
ΦB-ΦC.												

Equipment / Feeder Under Test: _____ **Start Time:** _____ **End Time:** _____

	0.5 min	1 min	2 min	3 min	4 min	5 min	6 min	7 min	8 min	9 min	10 min	P.I.
ΦA-Gnd.												
ΦB-Gnd.												
ΦC-Gnd.												
NEUT -Gnd.												
ΦA-ΦB												
ΦA-ΦC												
ΦB-ΦC.												

Notes: *Megger test only should record 5 minute value*
Polarization Index (P.I.) is 10 min reading divided by 1 min reading

END OF SECTION

SECTION 16620N

STANDBY POWER SYSTEM - NATURAL GAS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide a complete standby power system at the Pump Station as indicated in the Contract Documents. The system shall be a factory built, prototype tested, production tested, field tested, complete and operable emergency / standby electric generating system, including all devices and equipment specified herein, shown on the Drawings, and/or as required for the service. Materials and equipment shall be new and current, delivered to the site completely wired, tested, and ready for installation. This system shall include the following:

1. An outdoor natural gas engine driven electric plant to provide standby electric power.
2. Engine-generator control console resiliently mounted on the generator set shall include complete engine start-stop control and monitoring system.
3. Starting batteries with battery charger for each engine-generator set.
4. Automatic load transfer controls to provide automatic starting and stopping of the electric plant and switching of the load shall be furnished by the generator supplier. Refer to specific requirements and specifications noted within this section.
5. Mounted and loose accessories, control devices, and other equipment as specified herein and/or as shown on Drawings.
6. Such other components, accessories, parts, tests, documents, and services, as needed to meet the performance requirements of this specification.
7. All necessary interconnecting wiring and connections to provide proper system operation. Electrical Contractor to coordinate branch circuits requirements with the type of service provided by the generator set manufacturer.

B. This equipment, including engine-generator sets, shall be manufactured by Cummins, Caterpillar, or equal as determined for this project.

1. The electric generating system described herein, including these components, shall be factory built, factory tested, and shipped by this single manufacturer, so there is one source of supply and responsibility for warranty, parts, and service. This manufacturer shall have a representative based within 150 miles of the installation site who can provide factory trained servicemen on a 24-hour per day basis, the required stock of replacement parts, and any technical assistance required.
2. Different manufacturers for the engine-generator set and the automatic load transfer controls will be acceptable providing that the equipment is fully tested together before shipment and the engine-generator set manufacturer is the source of supply and responsibility for warranty, parts and service.

3. The responsibility for performance to this specification in its entirety cannot be split up among individual suppliers of components comprising the system but must be assumed solely by the supplier of the system. The manufacturer shall furnish schematic and wiring diagrams for the engine-generator set(s).
4. All controls shall be the standard of the manufacturer who is engaged in the manufacture of generators and has them available for sale on the open market. Control parts shall be identified by part numbers of this manufacturer and shall have second source listing where applicable. Control systems that are supplied by a sub-vendor or subcontractor of the vendor and not incorporated within the documentation drawings of the generator manufacturer are not acceptable.
5. Complete load bank testing, building load testing, sound level testing and system equipment check-out will be required to be performed as part of the overall acceptance of this equipment.

C. The automatic load transfer control shall be installed in a separate enclosure, as specified within this Section and as shown on the drawings.

1.2 QUALITY ASSURANCE

A. The electric generating system must meet all requirements of NFPA 110 (Level 2) including design specifications, prototype tests, one-step full-load pickup, and installation acceptance.
B. The performance of the electric plant shall be certified by the manufacturer verifying the electric plant's full power rating, stability, and voltage and frequency regulation.
C. The complete standby power system installation, start-up and operating instructions shall be performed under the supervision of a factory-trained engineer/ representative of the system manufacturer.
D. Acceptable Manufacturers:
   1. Electric Plant:
      a. Cummins Power Generation
      b. Caterpillar
      c. Or equal
   2. Automatic Load Transfer Controls:
      a. Cummins Power Generation
      b. Caterpillar
      c. Or equal
   3. The design is based on a Cummins Generator.
   4. The equipment spacing, mounts, electrical wiring, ventilation equipment, fuel and exhaust components have all been sized and designed around the manufacturer listed. Any changes to the design based on other manufacturers will be the responsibility of the installing Contractor at no additional cost to the Owner based upon being an Owner approved equal.
E. Service:
   1. Replacement parts and factory authorized service shall be available within 24 hours.
F. Refer to Section 01800 for additional start-up, testing, and training requirements.

1.3 SUBMITTALS TO THE ENGINEER

A. Submit shop drawings per Section 01340. Provide complete shop drawings for each system and piece of equipment specified, including all auxiliary devices. Shop drawing submittals shall consist of a single hard cover binder with individual index tabs, table of contents and shall include:

1. Complete typewritten description of system operation(s), and ratings, including a listing of all auxiliary devices.
2. Manufacturer's data sheets and detailed dimensioned drawings for all pieces of equipment and auxiliary devices.
3. Complete interconnecting wiring diagrams, cross referenced with project specific equipment designations as indicated in the Contract Documents, indicating all required wiring between the electric plant control panel, the automatic load transfer controls and all auxiliary devices.
4. Independent testing laboratory reports indicating the performance test results of the electric plants including power rating, stability and voltage and frequency regulation.
5. Unless specified otherwise herein, all performance data and other information shall be as on the manufacturer's printed literature. Performance data shall be the result of test procedures in accordance with nationally recognized standards, plus such other procedures that are judged necessary by the manufacturer to ensure maximum service reliability for emergency systems, and shall be available for inspection by the Engineer upon request.
6. Equipment supplier shall submit complete detailed step load program and calculations as part of the shop drawing submittal to demonstrate compliance with the motor starting and performance criteria as specified elsewhere in this Section.
7. All testing data sheets for load bank testing results, building load testing and sound level testing shall be submitted for final acceptance.

1.4 TESTING

A. The intent of this specification is to provide equipment of proven reliability, compatibility and facilitate standardization. Three separate series of tests shall be performed:

- Factory Prototype Model Tests,
- Factory Production Model Tests, and
- Field Tests.

1. Factory Prototype Model Tests: The electric generating system consisting of prime mover, generator, governor, coupling and all controls must have been tested as complete unit on representative engineering prototype model as required by NFPA 110. The tests, being potentially damaging to the equipment tested, must not be performed on equipment to be sold, but on separate prototype models as specified by NFPA 110, and their accomplishment certified by means of documentation of the tests accompanying submittal data.

These tests shall have included:

a. Maximum power level (maximum kW).
b. Maximum motor starting capacity (maximum KVA) and voltage dip recovery within seven (7) cycles of applied load.
c. Structural soundness (Short-Circuit and Endurance Tests).
d. Torsiograph Analysis: The manufacturer of the engine-generator set shall verify that the engine-generator combination, as configured, is free from harmful torsional stresses. The analysis shall include correlation of empirical data from tests on a representative prototype unit. The empirical data must include spectrum analysis of the torsional transducer output within the critical speed range of the engine-generator set. Results of this analysis shall be made available to the specifier on request. Calculations based on engine and generator separately are not acceptable.
    i. Engine-generator cooling and combustion air requirements.
    ii. Transient response and steady-state speed control and voltage regulation.
    iii. Generator temperature rise per NEMA MG1.
    iv. Harmonic analysis and voltage waveform deviation per MIL-STD-705B.
    v. Three-phase short-circuit test for mechanical and electrical strength. With system operating at rated Volts, Amperes, power factor, and speed, the generator terminals must be short-circuited ten times on all three phases for a duration of thirty seconds. Engine-generator set must build up and perform normally without manual interventions of any kind such as resetting of circuit breakers or other tripping devices when the short circuit is removed. Circuit breaker minimum AIC Rating: 42,000.
e. Failure mode test for voltage regulator: With engine-generator set operating at no load, rated speed and voltage, the AC sensing circuit to the regulator must be disconnected for a period of at least one hour. The engine-generator set must be fully operational after the test, and without evidence of damage.
f. Endurance testing is required to detect and correct potential electrical and mechanical problems associated with typical operation.

2. Factory Production Model Tests: Before shipment of the equipment, the engine-generator set(s) and automatic load transfer controls shall be tested under rated load and power factor for performance and proper functioning of control and interfacing circuits. Automatic load transfer controls shall also be tested alone under rated load if rated load is larger than that of the engine-generator set(s). Testing at unity power factor only (resistance banks only) is not acceptable, since kW output is affected by the higher generator efficiency at unity power factor, and the KVAR for motor starting and regulation loads varies with power factor. Tests shall include:

a. Single step load pickup per NFPA 110.
b. Transient and voltage dip responses and steady state voltage and speed (frequency) checks. A summary of these test results shall be submitted a minimum of one month before the date of substantial completion.

3. Field Tests after Installation: After installation the engine generator set and automatic load transfer controls shall be fully tested as specified herein in the presents of the Owner and Engineer. Submit test data and tables for the following:
   a. Load bank testing.
   b. Building load testing.
   c. Sound level testing.
   d. Contractor is responsible to coordinate fuel connection to generator for natural gas feed to unit during testing and for final installation for this project. Refer to Division 15 and Civil Drawings for requirements.

1.5 WARRANTY

A. The complete standby electric power system, including 1800 r/min engine-generator set and transfer switch equipped with set exerciser, and running time meter, shall be warranted for a period of five (5) years or fifteen hundred (1,500) operating hours, whichever occurs first, from the date of Project Substantial Completion. Multiple warranties for individual components (engine, generator, controls, etc.) will not be acceptable. Satisfactory warranty documents must be provided. This warranty shall be detailed in available written documents and shall include all labor, parts and travel to and from fixed installations. In the judgment of the specifying authority, the manufacturer supplying the warranty for the complete system must have necessary financial strength and technical expertise with all components supplied to provide adequate warranty support.

B. Service Calls: Equipment supplier shall provide a 6-month Level I and one year Level II service calls on the automatic transfer switch and generator. The Level II Service call shall include a full maintenance check and a change of all fluids and filters. Refer to Section 01800 for additional information.

PART 2 - PRODUCTS

2.1 STANDBY GENERATOR

A. General:

1. This system shall include an engine-generator set meeting or exceeding the minimum ratings as tabulated below, on a continuous standby basis. This equipment shall be furnished and installed as listed below.

Maximum Allowable Starting Voltage Dip	Maximum Allowable Peak Voltage Dip	Maximum Allowable Freq. Dip	Maximum Surge kW Capability	Maximum Surge kVA Capability
20%	20%	10%	Per Manufacturer	Per Manufacturer

KW	KVA	Power Factor	Hz	Volts	Phase/Wire
20	20	1	60	240V	1 Phase, 3 Wire

2. The engine generator set shall be capable of reliably starting the connected loads in the order listed in the table below. This shall be accomplished without exceeding the voltage and frequency dip specifications, and without causing unacceptable operation of electrical equipment.

Load Name:	**Load Rating (HP / kVA)**	**Starting Method**
Step 1:		
Base	5 KVA	
Step 2:		
Pump No.1 or No.2	5 HP	VFD *

* The pumps will driven on a PWM Variable Frequency Drives which will be converting the single phase input to a 3 phase output.

3. The Standby Power System supplier shall have a complete understanding of the loads to be started and operated on emergency power, and the generator shall be properly sized and configured to perform the intended function.
4. Each engine-generator set shall be mounted on a heavy duty steel base to maintain proper alignment between components, and each set shall incorporate vibration isolators of the type and quantity as specified by the set manufacturer, whether mounted internally or externally to the set.
5. Gear reduction or gear reduced type generators are not acceptable.
6. The step load program results (both) shall provide a generator sizing which shall not exceed 85 percent loading for the system. Generators submitted which exceed this value will be rejected.

B. Engine:

1. The engine shall be certified to US EPA SI Stationary Emissions Regulations under the provisions of 40CFR Part 16, for Emergency Standby applications only, in effect as of January 2012.
2. Engine shall be Natural Gas fueled.
3. Engine shall be certified by the engine manufacturer as capable of driving a generator yielding a kW rating as specified herein. Engine shall be capable of driving the generator at this rating on a continuous standby basis for the duration of normal utility source interruptions per SAE J1349 conditions. De-rating of the generator will not be acceptable.
4. Fuel injection and valves shall not require adjustment while in service.
5. Maximum ambient air temperature: 122*F.
6. Engine equipment shall include the following:
   a. An electric starter(s) as required by the manufacturer.
   b. Positive displacement, mechanical full pressure lubrication oil pump, full flow lubrication oil filters with replaceable elements and dipstick oil level indicator.
   c. Replaceable dry element air cleaner.

d. Engine speed isochronous electronic governing system to control generator frequency within ±0.25% of rated frequency under steady state load conditions, and capable of parallel operation with load sharing controls.
e. Engine protection devices shall have sensing elements located on the engine to initiate the following preliminary alarms and engine shutdowns:
    i. Low coolant temperature alarm
    ii. Low lubrication oil pressure alarm
    iii. High coolant temperature alarm
    iv. Low lubrication oil pressure shutdown
    v. High coolant temperature shutdown
    vi. Overspeed shutdown
    vii. Overcrank lockout
    viii. Low coolant level shutdown
    ix. Loss of fuel pressure to generator alarm
    x. Selector switch not in auto position alarm contact
f. Engine starter battery charging alternator with solid-state voltage regulator.
g. Engine-mounted, thermostatically-controlled, water jacket heater(s) for ambient below 40 degrees F, to aid in quick starting for outdoor installation. Heater(s) shall be rated for the proper required outdoor installation.

7. Cooling System:
    a. Engine shall be radiator-cooled by engine-mounted radiator system including belt-driven pusher fan, coolant pump, and thermostat temperature control. Performance of components shall be as required by set manufacturer.
    b. Radiators shall be provided with a duct adapter flange permitting the attachment of air discharge duct directing the discharge of radiator air through the wall.
8. Engine Exhaust System:
    a. Exhaust muffler shall be provided for each engine of size as recommended by the set manufacturer. Muffler shall be of the critical type. Provide support for the muffler so its weight is not supported by the engine.
    b. Stainless steel flexible exhaust connection shall be provided as required for connection between engine exhaust manifold and exhaust line, in compliance with applicable codes and regulations.
    c. All components shall be properly sized to assure proper operation without excessive back pressure, when installed as shown on drawings.
    d. All parts of engine and generator shall be protected for hot areas being in contact with personnel anywhere on the unit. Provide guards or insulation as required by UL2200 at all "hot" locations of the generator including exhaust manifolds, flexible connections, etc., for a complete installation. Where not recommended or required for this application, the supplier is required to meet all safety and protective requirements of this section for alternative methods.

9. Engine Fuel System
    a. Provide complete natural gas engine fuel system, including all pressure regulators, strainers, and fuel solenoid control valves. The fuel system shall be plumbed to the generator set skid for ease of site connections to the generator set. A solenoid valve shall be provided to control the flow of fuel. Provide loss of fuel protection and alarm.
    b. Provide a primary regulator to be shipped loose with the generator and installed by the mechanical contractor. This shall be coordinated with the manufacturer and contractor if is required and shall be included when required.

C. Generator:
1. Generator shall be single-bearing, 2/3rd pitch, self-aligning, four-pole, synchronous type, revolving field, with amortisseur windings, with direct drive centrifugal blower for proper cooling and minimum noise, with temperature compensated solid-state voltage regulator, with brushless PMG exciter system. No brushes will be allowed. Telephone influence factor less than 50 per NEMA MG1.
2. Generator shall be directly connected to engine flywheel housing and driven through a flexible coupling to ensure permanent alignment; gear driven generators are not acceptable under this specification.
3. Insulation shall meet NEMA standards for Class H.
4. The maximum alternator temperature rise shall not exceed 125*C above ambient. Generator design shall prevent potentially damaging shaft currents.
5. In order to limit generator voltage distortion caused by harmonic currents, the generator sub-transient reactance shall not exceed 0.12 per unit as calculated by the generator supplier using the generator set base rating.
6. The three-phase, broad range, and reconnectable generator shall have 12 leads brought out to allow connection by user to obtain any of the available voltages for the unit. Refer to connected load tables for specific application.
7. Voltage regulator shall be solid-state design and shall function by controlling the exciter magnetic field between stator and rotor to provide no load to full load regulation of rated voltage within ± 1% during steady-state conditions.
    a. The engine-generator set and regulator must sustain at least 90% of no load voltage for ten (10) seconds with 250% of rated load at near zero power factor connected to its terminals.
    b. The voltage regulator shall be insensitive to severe load induced waveshape distortion from SCR or thyrister circuits, such as those used in battery charging (UPS) and motor speed control equipment.
    c. A rheostat shall provide a minimum of ±5% voltage adjustment from rated value.
8. The generator, exciter, and voltage regulator shall be designed and manufactured by the engine-generator set manufacturer so that the characteristics shall be matched to the torque curve of the prime mover. This design allows the prime mover to use its fullest power producing capacity (without exceeding it or over compensating) at speeds lower than rated, to provide the fastest possible system recovery from transient speed dips. A

system that routinely selects a linear-type (straight line) constant volts/hertz characteristic, without regard for the engine power and torque characteristics, will not meet this specification.

9. PMG Exciter shall be three-phase, full-wave rectified, with heavy-duty silicon diodes mounted on the common rotor shaft and sized for maximum motor starting loads. Refer to connected load tables for specific application.
10. Generator design shall be of the self-protecting type, as demonstrated by the prototype short-circuit test as described under "Testing" herein. All other generator performance criteria shall be equal to that of the specified equipment.

D. Engine-Generator Set Control:

1. The generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification. The control shall be mounted on the generator set. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered. The generator set mounted control shall include the following features and functions.
2. Control Switches
   a. Mode Select Switch. The mode select switch shall initiate the following control modes. When in the RUN or MANUAL position, the generator set shall start, and accelerate to rated speed and voltage as directed by the operator. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage. Provide not in auto contact for remote alarm indication.
   b. EMERGENCY STOP switch. Switch shall be Red “mushroom-head” pushbutton. Depressing the emergency stop switch shall cause the generator set to immediately shut down and be locked out from automatic restarting.
   c. RESET switch. The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.
   d. PANEL LAMP switch. Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically be switched off 10 minutes after the switch is depressed, or after the switch is depressed a second time.
3. Generator Set AC Output Metering. The generator set shall be provided with a metering set including the following features and functions:
   a. Analog voltmeter, ammeter, frequency meter, and kilowatt (KW) meter. Voltmeter and ammeter shall display all three phases. Ammeter and KW meter scales shall be color coded in the following fashion: readings from 0-90% of generator set standby rating: green; readings from 90-100% of standby rating: amber; readings in excess of 100%: red.

b. Digital metering set, 0.5% accuracy, to indicate generator RMS voltage and current, frequency, output current, output kW, kW-hours, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral voltages and shall display all three phase voltages (line-to-line or line-to-neutral) simultaneously.

c. Both analog and digital metering are required. The analog and digital metering equipment shall be driven by a single microprocessor, to provide consistent readings and performance.

4. Generator Set Alarm and Status Display

a. The generator set shall be provided with alarm and status indicating lamps to indicate non-automatic generator status, and existing warning and shutdown conditions. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. The generator set control shall indicate the existence of the following alarm and shutdown conditions on an alphanumeric digital display panel:

i. low oil pressure (alarm)
ii. low oil pressure (shutdown)
iii. oil pressure sender failure (alarm)
iv. low coolant temperature (alarm)
v. high coolant temperature (alarm)
vi. high coolant temperature (shutdown)
vii. engine temperature sender failure (alarm)
viii. low coolant level (alarm or shutdown—selectable)
ix. fail to crank (shutdown)
x. fail to start/overcrank (shutdown)
xi. over speed (shutdown)
xii. low DC voltage (battery)(alarm)
xiii. high DC voltage (battery)(alarm)
xiv. weak battery (alarm)
xv. high AC voltage (shutdown)
xvi. low AC voltage (shutdown)
xvii. under frequency (shutdown)
xviii. over current (warning)
xix. over current (shutdown)
xx. short circuit (shutdown)
xxi. ground fault (alarm) (optional—when required by code or specified)
xxii. overload (alarm)
xxiii. emergency stop (shutdown)
xxiv. selector switch not in "Auto"" (audible alarm)

b. Provisions shall be made for indication of four customer-specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above specified conditions. The non-automatic indicating lamp shall be red and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.

5. Engine Status Monitoring
   a. The following information shall be available from a digital status panel on the generator set control:
      i. engine oil pressure (psi or kPA)
      ii. engine coolant temperature (degrees F or C)
      iii. engine oil temperature (degrees F or C)
      iv. engine speed (rpm)
      v. number of hours of operation (hours)
      vi. number of start attempts
      vii. battery voltage (DC volts)
   b. The control system shall also incorporate a data logging and display provision to allow logging of the last 10 warning or shutdown indications on the generator set, as well as total time of operation at various loads, as a percent of the standby rating of the generator set.
   c. Provide auxiliary dry contacts for remote indication for the following:
      i. Generator Run Status
      ii. Generator Failure Alarm
      iii. Generator Warning Alarm
      iv. Low Battery Alarm
6. Engine Control Functions
   a. The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and # of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with a 15-second rest period between cranking periods.
   b. The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.
   c. The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.
   d. The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.
   e. The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which is capable of discriminating between failed sender or wiring components and actual failure conditions.
7. Alternator Control Functions
   a. The generator set shall include an automatic digital voltage regulation system that is matched and prototype tested by the engine manufacturer with the governing system provided. It shall be immune from malfunctions due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase RMS

sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of 58 HZ. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off. Adjustments shall be broad range, and made via digital raise-lower switches, with an alphanumeric LED readout to indicate setting level. Rotary potentiometers for system adjustments are not acceptable.

b. Controls shall be provided to monitor the output current of the generator set and initiate and alarm (over current warning) when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (over current shutdown). The protective functions provided shall be in compliance with the requirements of NFPA70.

c. Controls shall be provided to individually monitor all three phases of the output current for short circuit conditions. The control/protection system shall monitor the current level and voltage. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (short circuit shutdown). The protective functions provided shall be in compliance with the requirements of NFPA70.

d. Controls shall be provided to monitor the kW load on the generator set and initiate an alarm condition (overload) when total load on the generator set exceeds the generator set rating in excess of 5 seconds. Controls shall include a load shed control to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.

e. An AC over/under voltage monitoring system that responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.

f. A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 12VDC or more than 16 VDC. During engine cranking (starter engaged), the low voltage limit shall be disabled, and if DC voltage drops to less than 8 volts for more than two seconds a “weak battery” alarm shall be initiated.

g. When required by National Electrical Code or indicated on project drawings, the Control System shall include a ground fault monitoring relay. The relay shall be adjustable from 3.8-1200 amps and include adjustable time delay of 0-10.0 seconds. The relay shall be for indication only, and not trip or shut down the generator set. Note bonding and grounding requirements for the generator set and provide relay that will function correctly in system as installed.

h. Provide relay and auxiliary dry contract for remote generator failure alarm.
i. Provide relay and auxiliary dry contact for remote generator run status.
j. Provide relay and auxiliary dry contact normally closed when generator is running and normally open when generator shuts down for ventilation system.

E. Auxiliary Equipment:
1. Starting Battery: One (1) battery shall be supplied for each engine (12VDC control system) and shall be mounted in a battery rack within the engine-generator set skid base. Batteries shall be 12 Volt, heavy duty, lead-acid type. Batteries to be manufactured by Interstate Model 31-MHD threaded lug type with 950 CCA or District approved equal shall be supplied for each generator set with battery cables and connectors.
2. Battery Charger(s): A voltage regulated battery charger shall be provided for each engine-generator set. Chargers shall be equipped with float, taper, and equalize charge settings. Battery charger shall be SENS model NRG 22-10-RC, 10 Ampere, 12 Volt or District approved equal.
3. Coolant Heater
a. A coolant heater, rated for 120 Volts, 1500 Watts shall be provided as recommended by the manufacturer. The contractor shall provide power requirements including circuit breaker, conduit, wiring, plug, etc. necessary to operate the heater.
4. Emergency Stop remote push button control station: Shall be 40mm in size, red mushroom head, maintain type: push to open and pull to engage. Shall be installed in a pad-lockable NEMA 4X enclosure.

F. Outdoor Weather-Protective Enclosure
1. Generator set housing shall be provided factory-assembled to generator set base and radiator cowling. Housing shall provide ample airflow for generator set operation at rated load in the ambient conditions previously specified. The housing shall have hinged side-access doors and rear control door. All doors shall be lockable. All sheet-metal shall be primed for corrosion protection and finish painted with the manufacturers standard color using a two step electro-coating paint process, or equal meeting the performance requirements specified below. All surfaces of all metal parts shall be primed and painted. The painting process shall result in a coating which meets the following requirements:
i. Primer thickness, 0.5-2.0 mils. Top coat thickness, 0.8-1.2 mils.
ii. Gloss, per ASTM D523-89, 80% plus or minus 5%. Gloss retention after one year shall exceed 50%.
iii. Crosshatch adhesion, per ASTM D3359-93, 4B-5B.
iv. Impact resistance, per ASTM D2794-93, 120-160 inch-pounds.
v. Salt Spray, per ASTM B117-90, 1000+hours
vi. Humidity, per ASTM D2247-92, 1000+ hours
vii. Water Soak, per ASTM D2247-92, 1000+ hours

b. Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion

resistant and designed to minimize marring of the painted surface when removed for normal installation or service work.

c. Sound-attenuation enclosure shall reduce sound levels as follows:

Sound Level Requirements

Manufacturer	Sound Pressure Levels dBA at Full Load		
	1M	7M	15M
Cummins	89.9	70.0	66.38

d. Provide a complete and assembled Quiet Site II, Level 2, sound attenuated outdoor weather-protective engine generator unit for mounting on a concrete pad as shown on the contract drawings.
e. All equipment located and supplied within the enclosure shall be pre-wired by the generator manufacturer except for the battery charger and block heater which shall be wired in the field by the contractor.
f. The enclosure shall have all vibration isolation and shall be bolted to an outside concrete pad.
g. Enclosures shall be provided with motorized dampers for the exhaust and intake louvers to prevent the infiltration of ambient air when not in operation.
h. Refer to drawings for additional information.
i. Provide final field testing of sound levels as specified and as required by each city or town sound level requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be made in complete accordance with manufacturer's recommendations.
B. Install unit on concrete base and bolt to the base with stainless steel hardware at all locations. Also allow base to provide for servicing access and oil pan removal. Provide concrete contractor with concrete pad installation requirements.
C. Flexible connections shall be used on all connections to unit.
D. Fill the engine cooling system with a percentage of solution of ethylene glycol and water as required by the manufacturer.
E. Support muffler so that its weight is not supported by the engine. Exhaust pipe sizing shall be as required to maintain exhaust backpressure within the limits established by the generator set manufacturer. Refer to Division 15 for insulation, mounting, and installation of exhaust system.
F. Bond steel base, generator and engine frames and all equipment enclosures to main ground electrodes.
G. Provide a minimum of 4 - 3/4" stainless steel epoxy anchors to fasten the generator to the concrete foundation.
H. Set all required parameters for the Automatic Transfer Switch.

3.2 FIELD TESTS AFTER INSTALLATION

A. Testing requirements are in addition to those in Section 01800.

B. The complete installation shall be initially started and checked out for operational compliance by factory-trained representative(s) of the engine-generator set(s) manufacturer. The engine lubrication oil as recommended by the manufacturer for operation under environmental conditions specified, shall be provided by the engine-generator set(s) supplier.

C. Upon completion of initial start-up and system checkout, the supplier of the system shall perform a field test in the presence of the Contractor, Engineer and Owner's operating personnel to demonstrate load carrying capability and voltage and frequency stability.

D. The Contractor shall bear costs for fuel for the generator before startup and after successful testing and acceptance by the Engineer, water for pumps, and complete electrical system operating and functional in order to verify that generator will start the connected loads in the order specified.

E. 100% Load shall consist of resistive load bank. Unity power factor is suitable for on-site testing, provided that rated load tests at power factor have been performed by the manufacturer prior to shipment.

1. Records shall be maintained throughout the tests consisting of:
    a. Time-of-day
    b. Coolant temperature
    c. Cranking time until prime mover starts and runs
    d. Time required to come up to operating speed, voltage and frequency overshoot
    e. Time required to achieve steady-state condition with all switches transferred to the emergency position
    f. Voltage
    g. Frequency
    h. Current
    i. Oil pressure
    j. Ambient air temperature
    k. Kilowatts
    l. Power factor
    m. Battery charger rate at 5-minute intervals for the first 15 minutes
2. Data shall be recorded at 15-minute intervals throughout the test.
3. Continue this load test for 2 hours minimum per NFPA 110, (up to a max of 3 hours, if requested by the Owner or Engineer) observing and recording load changes and the resultant effect on voltage and frequency.
4. Return normal power, record the time delay on retransfer for each switch (set for 15 minutes minimum) and the time delay on prime mover cooldown period and shutdown.
5. Perform a building load test with the actual conditions of the load. This must be coordinated as a separate site visit for each station. Coordinate with Owner and Engineer to setup time and conditions of testing.

6. The manufacturer's representative shall test and verify all protective functions of the generator control by accessing the control system through the use of a laptop computer and simulating failure modes or fault conditions.
7. During or after the tests, the Owner's operating personnel shall be fully instructed by the factory-trained representative in the operation and maintenance of this equipment.
8. Perform and test sound level values for each of the sites based on conditions set forth in the specifications and as required by each local jurisdiction where applicable.
9. Provide standby power system resistive load bank test results and building load test results for site. The forms provided at the end of this specification shall be completed for each site.

3.3 SERVICE MANUALS AND PARTS BOOKS

A. The system manufacturer’s authorized local dealer shall furnish 3 complete hard copies each of the manuals for the generator (one complete set) and books listed below to be kept inside the enclosure and two sets for the Owner's files. The manufacturer shall also provide one CD with each of the manuals, instructions, lists, procedures, charts, wire diagrams, and schematics on them.
   1. OPERATING INSTRUCTIONS - with description and illustration of all switchgear controls and indicators; and engine and generator controls and indicators.
   2. PARTS CD - that illustrates and list all assemblies, subassemblies and components, except standard fastening hardware (nuts, bolts, washers, etc.).
   3. PREVENTATIVE MAINTENANCE INSTRUCTIONS - on the complete system that cover daily, weekly, monthly, biannual, and annual maintenance requirements and include a complete lubrication chart.
   4. ROUTINE TEST PROCEDURES - for all electronic and electrical circuits and for the main AC generator.
   5. TROUBLESHOOTING CHART - covering the complete Genset showing description of trouble, probable cause, and suggested remedy.
   6. RECOMMENDED SPARE PARTS LIST - showing all consumables anticipated to be required during routine maintenance and test.
   7. WIRING DIAGRAMS AND SCHEMATICS - showing function of all electrical components, corrected as required showing as-built conditions.

STANDBY POWER SYSTEM - RESISTIVE LOAD BANK TEST

Owner: _____ Date: _____

Project: _____

Contractor: _____

Equipment Manufacturer: _____

Equipment: _____

This certifies that the entire equipment/system has met the RESISTIVE LOAD BANK TESTING requirements of Section 16620, 16950 and all other applicable requirements of the contract documents.

_____ _____
(Authorized Representative of the Manufacturer) (Date)

_____ _____
(Contractor) (Date)

_____ _____
(Engineer) Wright-Pierce (Date)

STANDBY POWER SYSTEM - BUILDING LOAD TESTS

Owner: _____ Date: _____

Project: _____

Contractor: _____

Equipment Manufacturer: _____

Equipment: _____

TEST #1 ☐ TEST #2 ☐ TEST #3 ☐

This certifies that the entire equipment/system has met the BUILDING LOAD TESTING requirements of Section 16620, 16950 and all other applicable requirements of the contract documents.

_____ _____
(Authorized Representative of the Manufacturer) (Date)

_____ _____
(Contractor) (Date)

_____ _____
(Engineer) Wright-Pierce (Date)

END OF SECTION

STANDBY POWER SYSTEM - BUILDING LOAD TESTS

Owner: _____ Date: _____

Project: _____

Contractor: _____

Equipment Manufacturer: _____

Equipment: _____

TEST #1 ☐ TEST #2 ☐ TEST #3 ☐

This certifies that the entire equipment/system has met the BUILDING LOAD TESTING requirements of Section 16620, 16950 and all other applicable requirements of the contract documents.

_____ _____
(Authorized Representative of the Manufacturer) (Date)

_____ _____
(Contractor) (Date)

_____ _____
(Engineer) Wright-Pierce (Date)

END OF SECTION

APPENDIX A
Geotechnical Data Report

REPORT

20-0493 S

August 19, 2020

Geotechnical Data Report

Marjorie Street Sewer Pump Station
Force Main Project
Portsmouth, New Hampshire

Prepared For:
Wright-Pierce
Attention: Ms. Lisa M. Muscanell-DePaola, P.E.
169 Main Street
Middletown, Connecticut 06457

Prepared By:
S. W. Cole Engineering, Inc.
10 Centre Road
Somersworth, NH 03878-2926
T: 603-692-0088

S.W.COLE ENGINEERING, INC.

- *Geotechnical Engineering*
- *Construction Materials Testing and Special Inspections*
- *GeoEnvironmental Services*
- *Test Boring Explorations*

www.swcole.com

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3.0 SUBSURFACE CONDITIONS 3
3.1 Soil 3
3.2 Groundwater 3
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Appendix B Figures
Appendix C Exploration Logs & Key
Appendix D Laboratory Test Results

20-0493 S

August 19, 2020

Wright-Pierce
Attention: Lisa M. Muscanell-DePaola, P.E.
169 Main Street
Middletown, CT 06457

Subject: Geotechnical Data Report
Marjorie Street Sewer Pump Station
Force Main Project
Portsmouth, New Hampshire

Dear Lisa:

In accordance with our Services Agreement dated July 2, 2020, in conjunction with our Proposal dated April 17, 2020, we have performed subsurface explorations for the Marjorie Street Sewer Pump Station Force Main Project in Portsmouth, New Hampshire. This geotechnical data report provides a summary of our findings.

1.0 INTRODUCTION

1.1 Scope and Purpose

The purpose of our services was to explore subsurface conditions for the proposed pump station and provide geotechnical recommendations relative to foundations and earthwork associated with the proposed construction. This report summarizes our findings. Geotechnical recommendations are presented in our Geotechnical Design Report under separate cover.

2.0 EXPLORATION AND TESTING

2.1 Explorations

The subsurface exploration program consisted of four test borings (B-1 through B-4) and five non-sampled auger probes (P-1 through P-5) performed on July 15 and 16, 2020. The borings and probes were drilled by S. W. Cole Explorations, LLC. We selected and located the explorations jointly with Wright-Pierce prior to commencement

of exploration work. The four borings were drilled where Marjorie Street terminates, with Borings B-1 and B-2 made for a potential pump station located on the easterly side of the street, and Borings B-3 and B-4 for an alternate location on the westerly side of the street.

We performed five auger test probes along Marjorie Street and near the Essex Street-Middle Road intersection. Probes P-1 through P-3 were carried to the requested depth of 10.0 feet. Probes P-4 and P-5 encountered refusals at depth of 7.5 and 1.5 feet, respectively.

The approximate exploration locations are shown on the "Exploration Location Plan" attached as Sheet 1 in Appendix B. Logs of the test borings and a key to the notes and symbols used on the logs are attached in Appendix C.

2.2 Field Testing

The test borings were advanced by drive and wash methods, sampling where shown on the logs using primarily a split spoon sampler and Standard Penetration Testing (SPT) methods. SPT blow counts are shown on the logs.

We obtained a thin walled Shelby tube sample of silty clay soils for laboratory consolidation testing, and performed four field vane tests in the silty clay to assess soil strength. Field vane test results are shown on the logs.

2.2 Laboratory Testing

Laboratory testing on selected samples consisted of a one-dimensional consolidation test, one gradation test, two Atterberg limits (plasticity) tests and nine moisture content tests.

Consolidation and gradation test results are included in Appendix D. Moisture content and Atterberg limits test results are shown on the boring logs

3.0 SUBSURFACE CONDITIONS

3.1 Soil

Beneath surficial topsoil, the borings encountered fills overlying various native mixtures of silt, sand and clay. The fills consist of a heterogeneous mixture of soil materials with occasional organics and asphalt debris. In Boring B-2, the bottom of the fills may have intermixed with a relic topsoil layer. The fills and relic topsoil extend to depths varying from about 6.5 to 10 feet below grade.

Beneath the fills, the borings encountered medium to stiff consistency mixture of gray-brown silt, sand and clay extending to a depth of about 15 feet. In Boring B-4, this stratum is described as having comparatively loose characteristics.

Below this stratum, each boring encountered primarily soft gray silty clay extending to depths varying from approximately 25 to 28 feet. The clay soils are compressible and normally consolidated (i.e., without pre-consolidation relative to existing overburden pressures).

Beneath the silty clay, soils grade to primarily loose silts and fine sands overlying a relatively thin layer of loose to medium dense glacial till at depth.

Refusals were encountered at depths varying from 38 to 55 feet, deeper in Boring B-1 and B-2 made on the easterly side of Marjorie Street.

Please refer to the attached logs for more detailed subsurface information.

3.2 Groundwater

Soils were generally moist below a depth of about 5 feet in each test boring. Long term groundwater information is not available. It should be anticipated that groundwater levels will fluctuate, particularly in response to periods of snowmelt and precipitation, as well as changes in site use.

4.0 CLOSURE

We thank you for the opportunity to be of service to you for this project. If you have any questions or we may be of further assistance, please do not hesitate to contact us.

Sincerely,

S. W. Cole Engineering, Inc.

Digitally signed by Tony Hersh
DN: cn=Tony Hersh, o=S. W. Cole Engineering, Inc., ou, email=thersh@swcole.com, c=US
Date: 2020.08.19 19:30:44 -04'00'

Anthony J. Hersh, P.E.
Senior Geotechnical Engineer

AJH: rec

APPENDIX A

Limitations

This report has been prepared for the exclusive use of Wright-Pierce for specific application to the proposed Marjorie Street Sewer Pump Station Force Main Project in Portsmouth, New Hampshire. S. W. Cole Engineering, Inc. (S.W.COLE) has endeavored to conduct our services in accordance with generally accepted soil and foundation engineering practices. No warranty, expressed or implied, is made.

The soil profiles described in the report are intended to convey general trends in subsurface conditions. The boundaries between strata are approximate and are based upon interpretation of exploration data and samples.

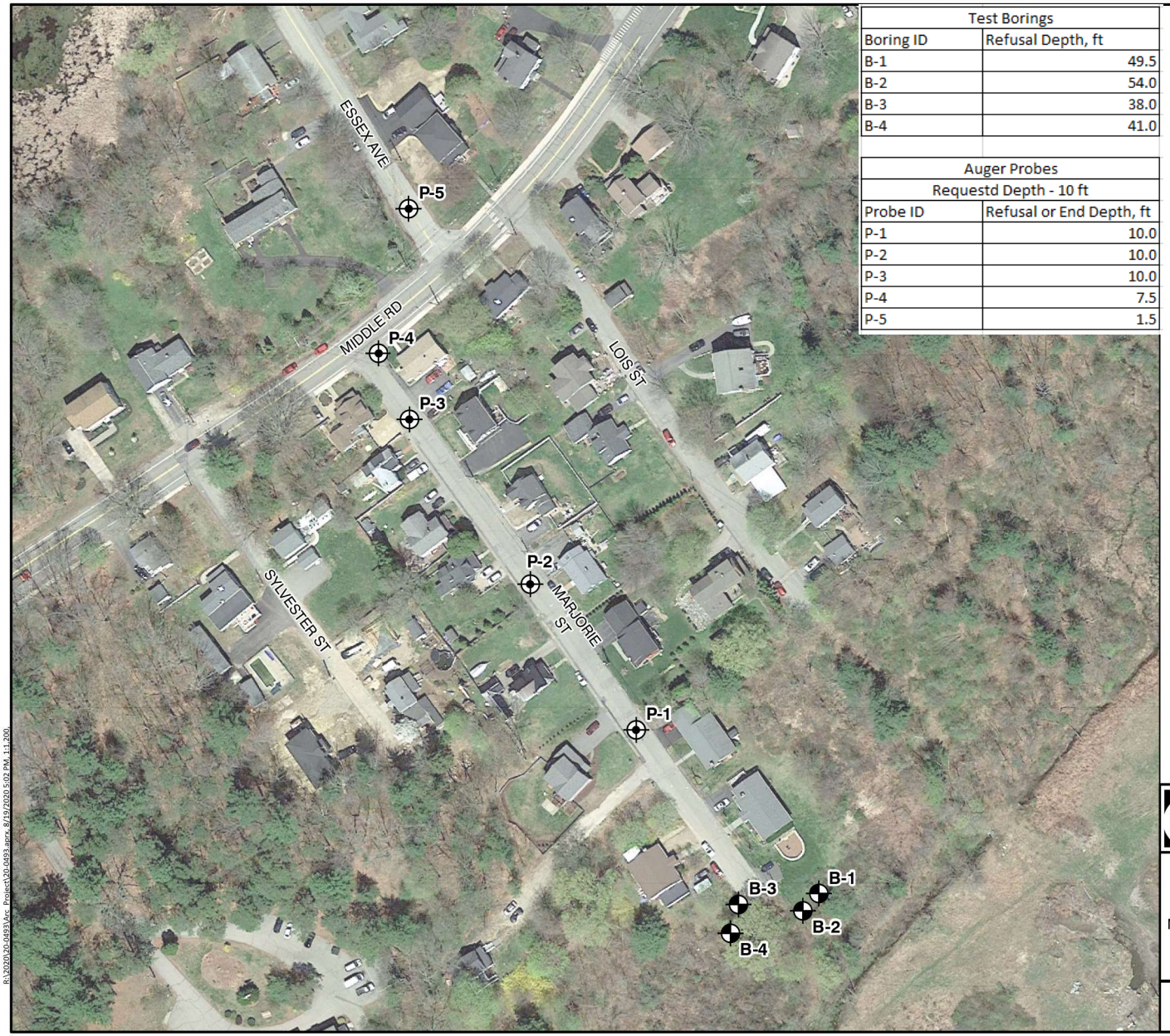
The analyses performed during this investigation and recommendations presented in this report are based in part upon the data obtained from subsurface explorations made at the site. Variations in subsurface conditions may occur between explorations and may not become evident until construction. If variations in subsurface conditions become evident after submission of this report, it will be necessary to evaluate their nature and to review the recommendations of this report.

Observations have been made during exploration work to assess site groundwater levels. Fluctuations in water levels will occur due to variations in rainfall, temperature, and other factors.

S.W.COLE's scope of services has not included the investigation, detection, or prevention of any Biological Pollutants at the project site or in any existing or proposed structure at the site. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria, and viruses, and the byproducts of any such biological organisms.

APPENDIX B

Figures



Test Borings	
Boring ID	Refusal Depth, ft
B-1	49.5
B-2	54.0
B-3	38.0
B-4	41.0

Auger Probes	
Requestd Depth - 10 ft	
Probe ID	Refusal or End Depth, ft
P-1	10.0
P-2	10.0
P-3	10.0
P-4	7.5
P-5	1.5

N

LEGEND

- APPROXIMATE BORING LOCATION
- APPROXIMATE PROBE LOCATION

NOTES:

1. EXPLORATION LOCATION PLAN PREPARED FROM GOOGLE EARTH IMAGERY ACCESSED 08/19/2020.

2. THE EXPLORATIONS WERE LOCATED IN THE FIELD BY MEASUREMENTS FROM EXISTING SITE FEATURES.

3. THIS PLAN SHOULD BE USED IN CONJUNCTION WITH THE ASSOCIATED S. W. COLE ENGINEERING, INC. GEOTECHNICAL REPORT.

4. THE PURPOSE OF THIS PLAN IS ONLY TO DEPICT THE LOCATION OF THE EXPLORATIONS IN RELATION TO THE EXISTING CONDITIONS AND PROPOSED CONSTRUCTION AND IS NOT TO BE USED FOR CONSTRUCTION.

0 50 100 200 300 Feet

S.W.COLE ENGINEERING, INC.

WRIGHT-PIERCE

EXPLORATION LOCATION PLAN

MARJORIE STREET SEWER PUMP STATION FORCE MAIN PROJECT
PORTSMOUTH, NEW HAMPSHIRE

Job No.	20-0493	Scale	1" = 100'
Date:	08/19/2020	Sheet	1

R:\2020\20-0493\Arc Project\20-0493.aprx, 8/19/2020 5:02 PM, 1:1,200

APPENDIX C

Exploration Logs and Key

BORING LOG

S.W.COLE ENGINEERING, INC.

CLIENT: Wright-Pierce
PROJECT: Proposed Pump Station
LOCATION: Essex Ave & Marjorie St, Portsmouth, NH

BORING NO.: B-1
SHEET: 1 of 2
PROJECT NO. 20-0493
DATE START: 7/16/2020
DATE FINISH: 7/16/2020

Drilling Information

LOCATION: See Exploration Location Plan | **ELEVATION (FT):** | **TOTAL DEPTH (FT):** 49.5 | **LOGGED BY:** Tyler Demers
DRILLING CO.: S.W.Cole Explorations, LLC | **DRILLER:** Sam Shaw | **DRILLING METHOD:** Cased Boring
RIG TYPE: Track Mounted Mobile Drill B-53 | **AUGER ID/OD:** N/A / N/A | **SAMPLER:** Standard Split-Spoon
HAMMER TYPE: Automatic / Automatic | **HAMMER WEIGHT (lbs):** 140 / 140 | **CASING ID/OD:** 4 in / 4 1/2 in | **CORE BARREL:** N/A
HAMMER EFFICIENCY FACTOR: | **HAMMER DROP (inch):** 30 / 30
WATER LEVEL DEPTHS (ft): Soils appear saturated below 5 feet
GENERAL NOTES:

KEY TO NOTES AND SYMBOLS:
Water Level: ▽ At time of Drilling; ▼ At Completion of Drilling; ▼ After Drilling
D = Split Spoon Sample; U = Thin Walled Tube Sample; R = Rock Core Sample; V = Field Vane Shear
Pen. = Penetration Length; Rec. = Recovery Length; bpf = Blows per Foot; mpf = Minute per Foot
WOR = Weight of Rods; WOH = Weight of Hammer; RQD = Rock Quality Designation; PID = Photoionization Detector
S_v = Field Vane Shear Strength, kips/sq.ft.; q_u = Unconfined Compressive Strength, kips/sq.ft.; Ø = Friction Angle (Estimated); N/A = Not Applicable

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION: Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD	Field / Lab Test Data	Graphic Log	Sample Description & Classification	H_2O Depth	Remarks
			1D		0-2	24/6	WOH-2-4-9			0.2 2" Grassed Topsoil		
			2D		2-4	24/6	8-5-6-7			Loose to medium dense, gray-brown-black Clayey Gravelly SILT and fine SAND with asphalt (Fill)		
	5		3D		5-7	24/0	3-1-1-2					
	10		4D		10-12	24/24	2-1-1-1			9.0 Stiff, gray-light brown Sandy SILT and CLAY		
										11.0 Soft, gray Silty CLAY with sand seam at 17.8 feet		
	15		1S		15-17	24/24		w =43.3 % W_L=34 W_P=19				
			1V		17-17.8	9/9		S_V=0.47/0.23ksf				
			2V		17.8-	0/0		S_V=No Pushksf				
			5D		17.8	24/24	1-WOH-					
	20				18-20		WOH-WOH					
	25		3V		25-25.8	9/9		S_V=0.59/0.18ksf				
			4V		25.8-26.6	9/9		S_V=0.66/0.2ksf				
										28.0 Loose gray SILT and fine SAND with clayey seams		
	30		6D		30-32	24/24	WOH-WOH-WOH-1	w =19.5 %				
	35											
	40		7D		40-42	24/12	3-3-4-7			40.0 Loose, gray SILT and fine SAND some clay		

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

(Continued Next Page)

S.W.COLE ENGINEERING, INC.

BORING LOG

CLIENT: Wright-Pierce
PROJECT: Proposed Pump Station
LOCATION: Essex Ave & Marjorie St, Portsmouth, NH

BORING NO.: B-1
SHEET: 2 of 2
PROJECT NO. 20-0493
DATE START: 7/16/2020
DATE FINISH: 7/16/2020

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION: Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD	Field / Lab Test Data	Graphic Log	Sample Description & Classification	H_20 Depth	Remarks
										48.0 Probable Glacial Till		

Refusal at 49.5 feet
(Probable Bedrock)

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

BORING LOG

S.W.COLE ENGINEERING, INC.

CLIENT: Wright-Pierce
PROJECT: Proposed Pump Station
LOCATION: Essex Ave & Marjorie St, Portsmouth, NH

BORING NO.: B-2
SHEET: 1 of 2
PROJECT NO. 20-0493
DATE START: 7/15/2020
DATE FINISH: 7/15/2020

Drilling Information

LOCATION: See Exploration Location Plan | **ELEVATION (FT):** | **TOTAL DEPTH (FT):** 54.0 | **LOGGED BY:** Tyler Demers
DRILLING CO.: S.W.Cole Explorations, LLC | **DRILLER:** Sam Shaw | **DRILLING METHOD:** Cased Boring
RIG TYPE: Track Mounted Mobile Drill B-53 | **AUGER ID/OD:** N/A / N/A | **SAMPLER:** Standard Split-Spoon
HAMMER TYPE: Automatic / Automatic | **HAMMER WEIGHT (lbs):** 140 / 140 | **CASING ID/OD:** 4 in / 4 1/2 in | **CORE BARREL:** N/A
HAMMER EFFICIENCY FACTOR: | **HAMMER DROP (inch):** 30 / 30
WATER LEVEL DEPTHS (ft): Soils appear saturated below 5 feet
GENERAL NOTES:

KEY TO NOTES AND SYMBOLS:
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S_v = Field Vane Shear Strength, kips/sq.ft.; q_u = Unconfined Compressive Strength, kips/sq.ft.; Ø = Friction Angle (Estimated); N/A = Not Applicable

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION: Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD	Field / Lab Test Data	Graphic Log	Sample Description & Classification	H_2O Depth	Remarks
			1D		0-2	24/8	5-3-4-7			0.2 2" Grassed Topsoil		
			2D		2-4	24/10	7-6-2-2			Medium dense, brown Gravelly SILT and fine SAND some clay (Fill) 2.5		
	5		3D		5-7	24/14	WOH-1-1-3			Loose, dark gray Gravelly SILT and fine SAND some clay with asphalt (Fill) 5.0		
										Loose, dark gray Clayey SILT and fine SAND with organics 6.5		
	10		4D		10-12	24/18	1-2-1-1	q_p=1.0-2.0 ksf		Medium, gray-light brown Sandy SILT and CLAY		
	15		5D		15-17	24/8	WOH-WOH-WOH-WOH			15.0 Soft, gray Silty CLAY		
	20		6D		20-22	24/24	WOH-WOH-WOH-WOH	w =34.5 %				
	25		7D		25-27	24/24	WOR-WOR-WOR-WOR	w =20.6 %		25.0 Loose gray SILT and fine SAND with clayey seams		
	30		8D		30-32	24/24	WOR-WOR-WOH-WOH	w =18.4 %				
	35		9D		35-37	24/24	WOH-WOH-WOH-2					
	40		10D		40-42	24/14	4-5-6-10			40.0 Medium dense, gray Silty fine SAND some clay		

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

(Continued Next Page)

S.W.COLE ENGINEERING, INC.

BORING LOG

CLIENT: Wright-Pierce
PROJECT: Proposed Pump Station
LOCATION: Essex Ave & Marjorie St, Portsmouth, NH

BORING NO.: B-2
SHEET: 2 of 2
PROJECT NO. 20-0493
DATE START: 7/15/2020
DATE FINISH: 7/15/2020

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION: Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD	Field / Lab Test Data	Graphic Log	Sample Description & Classification	H_20 Depth	Remarks
	50		11D		50-52	24/6	9-6-8-12			50.0 Medium dense, gray Gravelly SILT and SAND (Glacial Till)		

Refusal at 54.0 feet
(Probable Bedrock)

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

BORING LOG

S.W.COLE ENGINEERING, INC.

CLIENT: Wright-Pierce
PROJECT: Proposed Pump Station
LOCATION: Essex Ave & Marjorie St, Portsmouth, NH

BORING NO.: B-3
SHEET: 1 of 1
PROJECT NO. 20-0493
DATE START: 7/15/2020
DATE FINISH: 7/15/2020

Drilling Information

LOCATION: See Exploration Location Plan | **ELEVATION (FT):** | **TOTAL DEPTH (FT):** 38.0 | **LOGGED BY:** Tyler Demers
DRILLING CO.: S.W.Cole Explorations, LLC | **DRILLER:** Sam Shaw | **DRILLING METHOD:** Cased Boring
RIG TYPE: Track Mounted Mobile Drill B-53 | **AUGER ID/OD:** N/A / N/A | **SAMPLER:** Standard Split-Spoon
HAMMER TYPE: Automatic / Automatic | **HAMMER WEIGHT (lbs):** 140 / 140 | **CASING ID/OD:** 4 in / 4 1/2 in | **CORE BARREL:** N/A
HAMMER EFFICIENCY FACTOR: | **HAMMER DROP (inch):** 30 / 30
WATER LEVEL DEPTHS (ft): Soils appear saturated below 5 feet
GENERAL NOTES:

KEY TO NOTES AND SYMBOLS:
Water Level: ▽ At time of Drilling; ▼ At Completion of Drilling; ▼ After Drilling
D = Split Spoon Sample; U = Thin Walled Tube Sample; R = Rock Core Sample; V = Field Vane Shear
Pen. = Penetration Length; Rec. = Recovery Length; bpf = Blows per Foot; mpf = Minute per Foot
WOR = Weight of Rods; WOH = Weight of Hammer; RQD = Rock Quality Designation; PID = Photoionization Detector
S_v = Field Vane Shear Strength, kips/sq.ft.; q_u = Unconfined Compressive Strength, kips/sq.ft.; Ø = Friction Angle (Estimated); N/A = Not Applicable

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION: Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD	Field / Lab Test Data	Graphic Log	Sample Description & Classification	H_2O Depth	Remarks
			1D		0-2	24/8	3-4-5-3			Loose, brown Gravelly SILT and fine SAND some clay (Fill)		
			2D		2-3.1	13/4	3-15-50/1"					
	5		3D		5-7	24/14	WOH-WOH-1-1			5.0 Loose, dark gray Gravelly SILT and fine SAND some clay with organics (Fill)		
	10		4D		10-12	24/24	2-2-2-3	q_p=4.0-5.0 ksf		10.0 Stiff, gray-light brown Sandy SILT and CLAY		
	15		5D		15-17	24/6	WOH-WOH-WOH-WOH	w =41.8 %		15.0 Soft, gray Silty CLAY		
	20		6D		20-22	24/24	WOR-WOR-WOR-WOR	w =46 %				
	25		7D		25-27	24/12	WOH-WOH-WOH-WOH	w =19.7 %		25.0 Loose gray SILT and fine SAND with clayey seams		
	30		8D		30-32	24/6	WOH-WOH-WOH-WOH					
	35		9D		35-37	24/6	4-2-2-3			35.0 Loose, gray Gravelly SILT and SAND (Glacial Till)		

Refusal at 38.0 feet
(Probable Bedrock)

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

BORING LOG

S.W.COLE ENGINEERING, INC.

CLIENT: Wright-Pierce
PROJECT: Proposed Pump Station
LOCATION: Essex Ave & Marjorie St, Portsmouth, NH

BORING NO.: B-4
SHEET: 1 of 1
PROJECT NO. 20-0493
DATE START: 7/16/2020
DATE FINISH: 7/16/2020

Drilling Information

LOCATION: See Exploration Location Plan | **ELEVATION (FT):** | **TOTAL DEPTH (FT):** 41.0 | **LOGGED BY:** Tyler Demers
DRILLING CO.: S.W.Cole Explorations, LLC | **DRILLER:** Sam Shaw | **DRILLING METHOD:** Cased Boring
RIG TYPE: Track Mounted Mobile Drill B-53 | **AUGER ID/OD:** N/A / N/A | **SAMPLER:** Standard Split-Spoon
HAMMER TYPE: Automatic / Automatic | **HAMMER WEIGHT (lbs):** 140 / 140 | **CASING ID/OD:** 4 in / 4 1/2 in | **CORE BARREL:** N/A
HAMMER EFFICIENCY FACTOR: | **HAMMER DROP (inch):** 30 / 30
WATER LEVEL DEPTHS (ft): Soils appear saturated below 5 feet
GENERAL NOTES:

KEY TO NOTES AND SYMBOLS:
Water Level: ▽ At time of Drilling; ▼ At Completion of Drilling; ▼ After Drilling
D = Split Spoon Sample; U = Thin Walled Tube Sample; R = Rock Core Sample; V = Field Vane Shear
Pen. = Penetration Length; Rec. = Recovery Length; bpf = Blows per Foot; mpf = Minute per Foot
WOR = Weight of Rods; WOH = Weight of Hammer; RQD = Rock Quality Designation; PID = Photoionization Detector
S_v = Field Vane Shear Strength, kips/sq.ft.; q_u = Unconfined Compressive Strength, kips/sq.ft.; Ø = Friction Angle (Estimated); N/A = Not Applicable

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION: Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD	Field / Lab Test Data	Graphic Log	Sample Description & Classification	H_2O Depth	Remarks
			1D		0-2	24/4	3-2-2-3			0.2 2" Topsoil Loose, brown Gravelly SILT and fine SAND (Fill)		
			2D		2-4	24/6	4-5-3-3					
	5		3D		5-7	24/6	1-2-1-2			6.0 Loose, dark gray Gravelly SILT and fine SAND some clay with organics (Fill)		
	10		4D		10-12	24/24	5-4-3-2			10.0 Loose, brown-gray Clayey SILT and fine SAND		
	15		5D		15-17	24/24	WOH-WOH-WOH-WOH			15.5 Soft to medium, gray Silty CLAY		
	20		1V		20-20.8	9/9		S_V=0.56/0.18ksf				
			2V		20.8-21.6	9/9		S_V=0.76/0.21ksf				
	25				25-25.8	9/9		S_V=0.76/0.22ksf				
					25.8-26.6	9/9		S_V=1.06/0.24ksf				
	30		6D		30-32	24/24	WOH-WOH-WOH-WOH	w =23.1 %		28.0 Loose gray SILT and fine SAND with clayey seams		
										33.0 Loose, gray Gravelly SILT and SAND (Glacial Till)		
	35		7D		35-37	24/0	3-4-5-5					
	40									39.0 Probable Weathered Bedrock		

Refusal at 41.0 feet
(Probable Bedrock)

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

KEY TO NOTES & SYMBOLS
Test Boring and Test Pit Explorations

Stratification lines represent the approximate boundary between soil types and the transition may be gradual.

Key to Symbols Used:

w	-	water content, percent (dry weight basis)
q_u	-	unconfined compressive strength, kips/sq. ft. - laboratory test
S_v	-	field vane shear strength, kips/sq. ft.
L_v	-	lab vane shear strength, kips/sq. ft.
q_p	-	unconfined compressive strength, kips/sq. ft. – pocket penetrometer test
O	-	organic content, percent (dry weight basis)
W_L	-	liquid limit - Atterberg test
W_P	-	plastic limit - Atterberg test
WOH	-	advance by weight of hammer
WOM	-	advance by weight of man
WOR	-	advance by weight of rods
HYD	-	advance by force of hydraulic piston on drill
RQD	-	Rock Quality Designator - an index of the quality of a rock mass.
γ_T	-	total soil weight
γ_B	-	buoyant soil weight

Description of Proportions:

Trace:	0 to 5%
Some:	5 to 12%
"Y"	12 to 35%
And	35+%
With	Undifferentiated

Description of Stratified Soils

Parting:	0 to 1/16" thickness
Seam:	1/16" to 1/2" thickness
Layer:	½" to 12" thickness
Varved:	Alternating seams or layers
Occasional:	one or less per foot of thickness
Frequent:	more than one per foot of thickness

REFUSAL: **Test Boring Explorations** - Refusal depth indicates that depth at which, in the drill foreman's opinion, sufficient resistance to the advance of the casing, auger, probe rod or sampler was encountered to render further advance impossible or impracticable by the procedures and equipment being used.

REFUSAL: **Test Pit Explorations** - Refusal depth indicates that depth at which sufficient resistance to the advance of the backhoe bucket was encountered to render further advance impossible or impracticable by the procedures and equipment being used.

Although refusal may indicate the encountering of the bedrock surface, it may indicate the striking of large cobbles, boulders, very dense or cemented soil, or other buried natural or man-made objects or it may indicate the encountering of a harder zone after penetrating a considerable depth through a weathered or disintegrated zone of the bedrock.

APPENDIX D

Laboratory Test Results

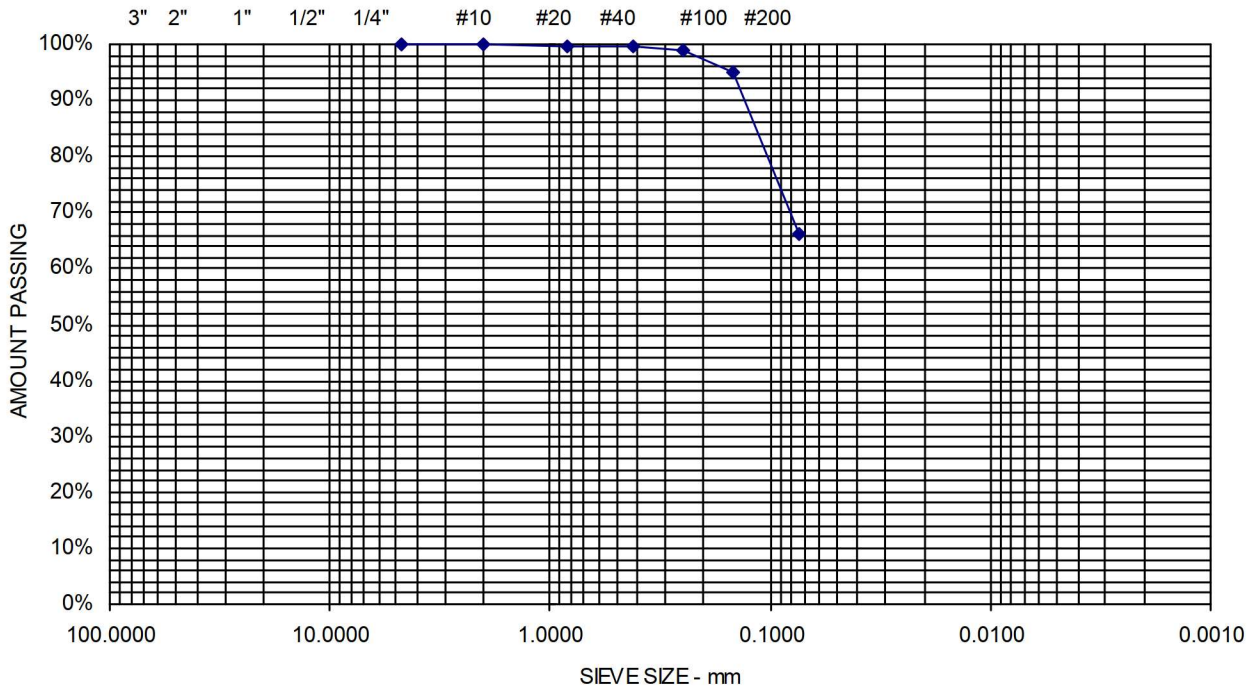
S.W.COLE ENGINEERING, INC.

Report of Gradation

ASTM C-117 & C-136

Project Name	PORTSMOUTH NH - MARJORIE STREET PUMP STATION AND FORCE MAIN PROJECT - GEOTECHNICAL ENGINEERING SERVICES	Project Number	20-0493
Client	WRIGHT-PIERCE	Lab ID	19924S
Exploration	**B-4**	Date Received	7/22/2020
Material Source	**B-4, 6D, 30-32'**	Date Completed	8/4/2020
		Tested By	BRADLEY GERSCHWILER

STANDARD DESIGNATION (mm/µm)	SIEVE SIZE	AMOUNT PASSING (%)	
4.75 mm	**No. 4**	**100**	0% Gravel
2.00 mm	**No. 10**	**100**	
850 um	**No. 20**	**100**	
425 um	**No. 40**	**100**	33.7% Sand
250 um	**No. 60**	**99**	
150 um	**No. 100**	**95**	
75 um	**No. 200**	**66.3**	66.3% Fines



Comments: Moisture Content = 23.1%

Sheet

S.W.COLE ENGINEERING, INC.

Consolidation Test

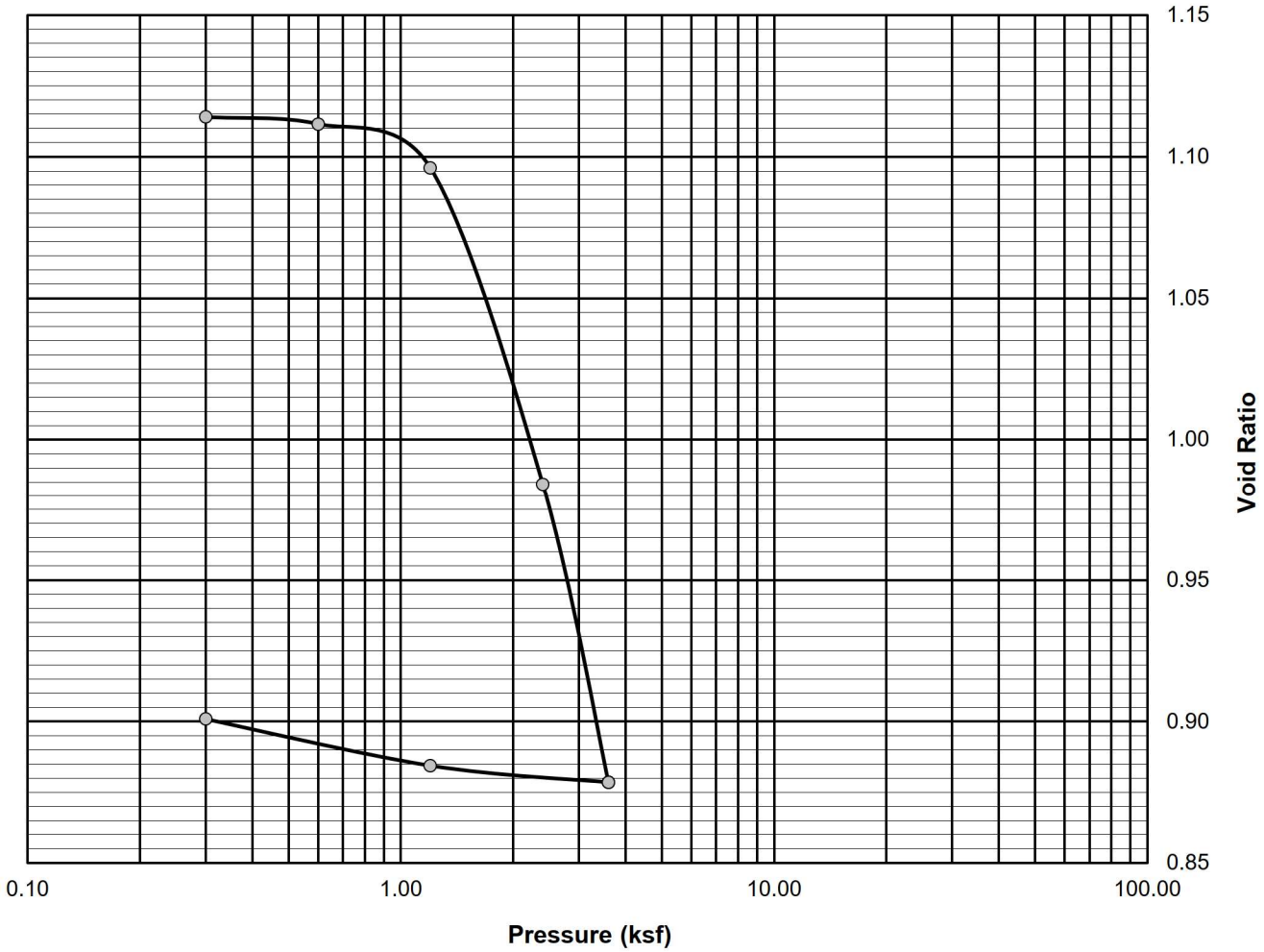
ASTM D-4767

Project Name: Marjorie St. Pump Station and Force Main Project
Client: Wright-Pierce

Project Number: 20-0493
Lab ID: 26055B
Date: 7/19/2020

Boring: B-1
Sample: 1U
Depth: 15-17'

P_C =	1.1 ksf +/-
C_C =	0.61
C_R =	0.02
w =	43.3%
W_L =	34
W_P =	19



Comments:

Anthony Hersh

Reviewed By

APPENDIX B
Contractor Laydown Area Map


Google Earth
N
900 ft

WRIGHT-PIERCE™

Engineering a Better Environment